Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXVI. JUNE, 1924 No. 6

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EDITORIALS

DISSIPATING MOTOR VEHICLE TAXES

Motor vehicle owners, as well as workers in the highway field, will do well to recognize the present tendency toward the dissipation of motor vehicle taxes and to be on their guard against it.

The motor vehicle license fee and the gasoline tax are now very important sources of revenue for state highway departments in the great majority of the states. The trend, in this connection, is unmistakably away from high general taxes for road work and toward increased license fees and gas taxes. This is concentrating many millions of dollars in the hands of a single spending agency, the state highway department, and these large sums are attracting the envious attention of local road and street authorities, who are agitating for a return of more and more motor vehicle tax money for use in the neighborhood where the vehicle is owned and where it has most of its use.

Every local highway authority in the country could make good use of increased funds and it is a natural impulse to oppose sending license fee and gas tax money out of a city or county for use on a state highway, at some point remote from the source of this revenue, when there is urgent need for increased funds for road and street work closer home. We believe, however, that careful consideration will show the unwisdom of breaking up the proceeds of motor vehicle and motor fuel taxes into such small sums that the state highway departments will be robbed without enriching the local road and street departments.

On close study this problem will be found to be one in simple arithmetic. There would be little danger of dissipating the funds in question if all the thinking on the subject were done with a lead pencil and pad of paper. A little study of the situation in most states where local road and street work has been carried on for years will show that the present expenditures for state highways are insignificant in comparison with present expenditures for road and street work by counties, townships, cities and towns. Readers will find it an interesting study to sum up all of these local road and street expenditures, including interest on bonds, for any year, and compare this total with the total expenditure of the state highway department for the same year. We predict that the result of this comparison will surprise even a great many who have paid close attention to highway and motor affairs, and it will astound those who have never made any sort of analysis of road and street expenditures. Included in the latter class will be found many city, county and township officials, state legislators, as well as business men in all lines. The element of surprise, as already suggested, lies in the fact that the direct outlay on a state highway system, even though it amounts to several million dollars a year, is but a very minor part of the total expenditure for roads and streets of all the political subdivisions of the state. In some cases the editor has analyzed he has found that the total suspension of state highway department activities and the return of every cent of motor vehicle and gas tax revenues to local authorities would not appreciably lighten local taxation, although absolutely wrecking the connected, statewide highway activities.

The motor vehicle owner and the local public official should realize that they are, first of all, citizens of the state in which they live. If they believe in the upbuilding of a state-wide system of connected highways, and they do, they must be careful not to encourage the taking away of funds now available for the development of State Highway Systems unless they first provide an equal amount of money for state use from some other source. In this connection it should be noted that local roads and streets are very old institutions and they have been successfully financed for many, many years. The State Highway System is a new thing, brought into being by another new thing, the motor vehicle. It is a natural devel-

opment, and to a great degree an equitable and a logical development, to finance these State Highway Systems with revenue derived from the motor vehicle. While the motor vehicle is a new revenue producer, it is also a new revenue consumer, and we must be careful not to overlook this fact.

After it is realized that it is unwise to take this money from the State, we hope the public will insist that all this money continue to go into the state road fund and not into the school fund or the general fund. There is a temptation, now, to divert this money to the general needs of the state, and it would seem wise for local authorities to insist that the motorists' money continue to go into state roads rather than into schools, benevolent and penal institutions, etc. All politicians are anxious to lower the direct tax rate and they are tempted to utilize indirect revenues for this purpose. Therein lies a real danger which can be avoided only by vigilance.

Let us safeguard the expenditure of revenues from the motor vehicle so as to do the most good for the most people. This requires the use of this money on state rather than on local roads, and rather than for the general needs of the state entirely aside from roads.

GROWTH OF THE CONTINUOUS HIGHWAY DEVELOPMENT IDEA

It is beginning to sink into the public as well as the official mind that in our state highway development we have been living from hand to mouth. We have been doing piece-work and patch-work. We have spent our money and stopped, often far short of where we had hoped to get. Against this improvident practice the people are beginning to warm up to the idea of having *an adequately financed highway development program, of a comprehensive character, extending over a considerable period of years.*

The problem of finance is the most important one connected with highway development. It is assumed by many that this is handled largely by bonding. Generally speaking, this is not true. More than half the states in the Union have not bonded for state highway construction. Where states do not bond dependence must be placed in current revenues from general property and motor vehicle taxes for road purposes. Even when a state can and does bond itself for road building, the current revenues mentioned are still highly important. It is coming to be appreciated that in the absence of a comprehensive program extending over a period of years, it is not possible to devise an equitable system of taxation.

The states have laid out, *on paper*, state-wide systems of highways. They are making some progress in hard-surfacing these systems and the systems are pretty well maintained. Much highly commendable work has been done, but scarcely more than a beginning has been made. The time has come to look ahead and plan for a definite period of five to ten years. With such a program we can hope to get some place in the fairly near future. Without such a program there is real danger of interruption even to the very moderate rate of progress we have been making, for the people are growing restless and impatient because the progress to date has been so slow.

It would be a fine thing for this country if every state would now decide what it intends to do on its state highway system for the next five or ten years. The rate at which the system is to be extended should be planned for the future. The amount and character of maintenance work should be planned also. The rate of progress on bridge building and grade separation and in hard-surfacing should also be planned. It would then be comparatively easy to budget the expenditures for each year, and this would enable state legislatures to enact the requisite revenue measures in fairness to all. Now the legislators are very much in the dark and at sea. They don't know how much money to raise or where to get it.

The people would like to know what to expect. It certainly is not very complimentary to the people to assume that more can be done for them by pussyfooting than by frank and open planning. In talking with many groups of people the editor finds the program idea makes an immediately favorable appeal. It isn't necessary to slip up behind a man and lay down a road for his use. He wants to know what to expect; then he is willing to pay his share of highway costs. He doesn't object to waiting for something that is surely coming at a definite date, but he does hate to wait for something that may not come at all or that may come at some vague and remote date in the unknown future.

DESIGN AND CONSTRUCTION OF SAND ASPHALT PAVEMENTS

By Sam R. Murray, 101 N. Denny St., Indianapolis, Ind.

(Editor's Note: The author of this article installed the municipal asphalt plant for the City of Indianapolis in 1908, one for Denver in 1910, one for Fayette County, Kentucky, in 1916, and one for the State Highway Department of North Carolina in 1922. Under his direct supervision more than one million square yards of asphalt pavements have been constructed in the past 30 years. Until recently he was Superintendent of Street Construction and Repair for the City of Milwaukee, Wis.)

The sand asphalt pavement was originally adapted to localities where sand abounded in large quantities with no stony material available, and where not sufficient clay existed to make a sand-clay road. The sand asphalt pavement originated in New England where a large yardage was laid in the state of Massachusetts, using coal tar as a binding material, however, instead of asphalt.

It was originally laid with sand, or bank run gravel. The material was dried and heated in what was known as a hot mixer together with sufficient bituminous cement to make a plastic, waterproof wearing surface after being laid on the road and compressed.

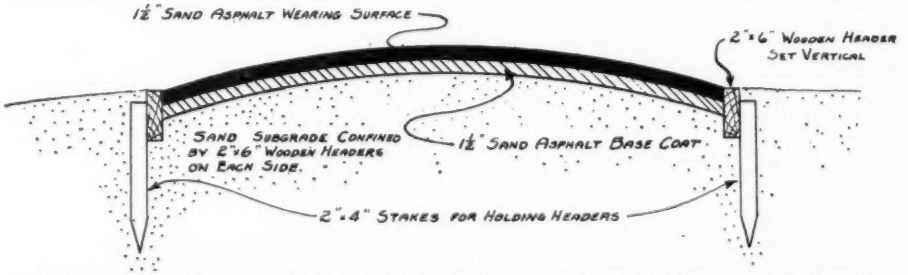
Its chief advantage lay in the fact that none of the materials used in its construction were expensive and that it could be laid by almost any contractor without having a large investment in a paving plant and equipment. Another great advantage was, that it could be laid on the existing foundation, either gravel, waterbound macadam, or in a great many instances, on the sand sub-grade itself.

It was introduced in the state of Florida on the west coast in the city of Eustis in 1914, where a small quantity was laid by a New England contractor in front of a hotel in which he was interested. This was mixed in heating pans, laid directly on the sand subgrade and was still in use when the writer saw it in 1919.

The writer was employed by one of the asphalt supply companies to go to Florida in the winter of 1914 and 1915 to instruct a contractor in the proper laying of this type of pavement, in the city of Tarpon Springs on the west coast. Prior to this time there had been none of this pavement laid in the South with a modern paving plant; the small amount which had been laid, having been mixed in heating pans. It required much experimentation to devise the proper method of laying the material on the sand subgrade in the quantities produced by a paving plant. Several methods were tried out, but the type of construction eventually arrived at was substantially as follows:

FINISHED SAND-ASPHALT STREET IN MT. DORA, FLA., LAID BY FORCE ACCOUNT IN 1916.

A cement curb was provided 5 ins. in width by 24 ins. in depth, as this was in a residence district. The sand was then graded down to a proper cross section and 4 ins. below the proposed surface of the finished pavement. A coat of 2½ ins. of native sand, with no attempt at gradation, was mixed with just sufficient


1½" Sand Asphalt Wearing Surface
2"×6" Wooden Header Set Vertical
Sand Subgrade Confined by 2"×6" Wooden Headers on Each Side.
1½" Sand Asphalt Base Coat
2"×4" Stakes for Holding Headers

CROSS SECTION OF SAND-ASPHALT ROAD AS BUILT BY NORTH CAROLINA STATE HIGHWAY DEPARTMENT.

asphalt to bind it together properly, and then laid on this sand subgrade. The latter was compacted by means of wetting as it was found more feasible than to attempt to roll the loose sand. In this instance the sand had been pumped from a bayou to make the fill for this street which was in a real estate sub-division.

As this sand had not had an opportunity to be blown around by the wind, the grains had not become rounded and were irregular in shape, and compacted very well in the presence of some moisture, as long as there was not sufficient water contained in the same to separate the grains. It was found that about 7% to 8% of bitumen was sufficient to coat the sand grains and bind them together This mixture was laid in the afternoon and a hand surface roller employed to compact and compress this cushion or base coat. Where the surface appeared too smooth after it had slightly cooled, it was roughened up with the teeth of an asphalt rake in order to assist in the binding and eliminate any shoving of the surface coat, which was 1½ ins. in thickness.

By the results of our experiments, it was found that this material cooled and hardened sufficiently during the night so that the surface coat could be laid over it, raked and a fairly good compression by the roller obtained. The surface coat was more carefully graded, and in some instances, some additional filler of 200 mesh material was added.

There was no attempt made to secure, what was considered by paving men, an ideal sheet asphalt surface mixture, for in this case the price would have been increased to such an extent that the object of the pavement, that of securing an inexpensive type, would not have been attained.

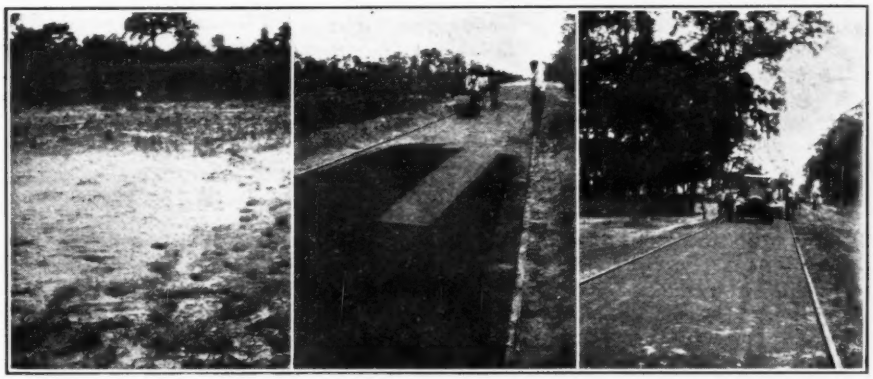
The most important point to be considered in the laying of this type of pavement on a sand sub-base is to have the sand subgrade confined at the edges in order that it may not be shoved out and the road thus flattened by traffic.

This street and its construction was carefully watched by the commissioners in the surrounding counties and by officials of some of the smaller cities in Florida. Mount Dora constructed about two miles of this pavement on a sand-clay base. Saint Cloud and some of the other cities constructed small yardages on the sand subgrade. Polk county purchased sufficient asphalt cement and engaged an engineering concern to supervise the construction of five, one-quarter mile sections in various parts of the county, some of which were laid on the sand subgrade and some on a sand-clay base, in order that the voters after observing the use of these sections could vote on a bond issue for paving the county roads with some suitable pavement. After the residents in the county had observed these sections for some time, they voted a large bond issue for the paving of the county roads and in this county at the present time, there are 312 miles of the sand asphalt and sheet asphalt type of road surfacing, much of which was laid on a sand-clay base.

This sand clay base consisted of incorporating sufficient clay, usually 25 per cent, into the sand subgrade itself, harrowing it in and mixing it by discing and otherwise so that a very compact crust was made over the existing sand, which had sufficient supporting strength to carry the sand asphalt surfacing on top.

In the year 1922 the writer was engaged by the North Carolina State Road Department to build a sample section of the sand asphalt road along the eastern coast of North Carolina, northeast of Wil-

SAND-ASPHALT STREET CONSTRUCTION IN TARPON SPRING, FLA., 1915.
Left: View of Sandy Street with Paving Plant in Distance. Right: Cushion Coat and Section of Completed Sand-Asphalt Street.



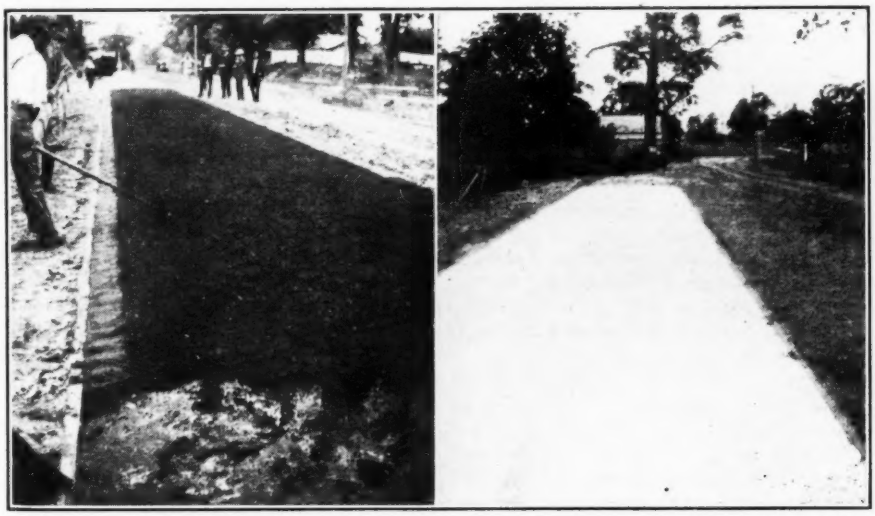
CONSTRUCTION OF SAND-ASPHALT ROAD IN NORTH CAROLINA IN 1921.
Left: Sandy Country Through Which Road Was Built. Center: Laying and Rolling Cushion or Base Coat. Right: Trucking Surface Coat Over Base Coat, Showing Wooden Headers Along Edges.

mington. The State had no specification for this road, and as the contractors were not familiar with it, no contract could be let until a sample section was constructed. This sample section was built by using a 2x6-in. wooden header along each edge, set vertical, supported with 2x4-in. stakes about 2-ft. long, and driven 2-ft. apart. This was in order to retain the edges of the road and to keep the sand from being shoved out or displaced and thus allowing the road surface to become flattened.

Accompanying this article are some views of this North Carolina road in various stages of construction. We understand that instead of letting the balance of the road by contract, the State Road Department purchased some additional paving units and completed the entire road with day labor, thus saving the contractor's profit and leaving the State with some small paving plants which could be used in maintaining all types of asphalt or bituminous roads which were under State supervision.

At first in Florida, the road was called the "sand oil road," but this was erroneous as no oil on the market had sufficient body to bind the sand grains properly together, but the name, "sand oil road," was applied to this type of road for several years.

In the case of the North Carolina section built by the writer, the thickness was reduced to 1½ in. cushion or base coat and 1½-in. wearing surface coat, which he found of sufficient thickness to carry



LAYING SURFACE COAT ON WILMINGTON-NEWBERN, NORTH CAROLINA ROAD IN 1921, AND SECTION OF THE COMPLETED SAND-ASPHALT ROAD.

the traffic on this particular road, and the entire cost of the sample section excluding the investment in the paving plant was about $1 per sq. yd. In this case no outside material was brought in except the asphalt cement, filler and some fuel for the paving plant and rollers.

The writer is of the opinion that this is the least expensive type of durable road which can be built in a sandy community and there is no reason to believe that it will not give good service for at least 12 to 15 years, with very little attention or maintenance. Even in the Northern climate where the sand is of sufficient depth and far enough above the water level of the lakes and rivers to keep the sand subgrade in a dry condition, there is no reason why this would not be an inexpensive type of pavement which would give good results.

FIXING THE ULTIMATE WIDTH OF HIGHWAY RIGHT-OF-WAY IN PENNSYLVANIA

By William H. Connell, Engineering Executive, Pennsylvania Department of Highways, Harrisburg, Pa.

(Note: In the report made by William H. Connell in November, 1922, following his survey of Pennsylvania State Highway Department activities, two of his principal recommendations were that immediate steps should be taken to fix the ultimate width of the right-of-way of all the roads of the state highway system so the pavements could be widened to suit the increased traffic demands, and that a highway transport survey should be made with a view to forecasting the amount and character of the probable future traffic.)

The first plan for fixing the ultimate width of the right-of-way of the highways of the Pennsylvania state highway system was filed with the recorders of Delaware and Montgomery counties on May 16, 1924, for the section of the Lincoln highway from Philadelphia to Paoli. Plans for Route No. 133, between Philadelphia and West Chester, will be filed within a week.

All of the large cities in this country have learned their lesson at a great cost to the taxpayers as a result of failing to plan streets of sufficient width. The engineers of the Board of Estimates of New York City claim the traffic jam due to narrow streets has cost the people more than $300,000,000 a year in excess transportation costs due to the slowing up of traffic on narrow streets. Their findings point out that it would be far cheaper to pay the costs of acquiring the land and destroying the buildings, so the streets could be widened to make adequate provision for the traffic.

They state there is one way, and only one way, to keep the traffic stream moving; and that is to provide channels through which it may flow freely. This is a task which cannot be taken up piecemeal. It must be done on a comprehensive plan, and those who undertake it must have sufficient vision not to be frightened at the cost. The cost referred to with respect to New York City is the cost of acquiring land and buildings in built-up sections at fabulous prices simply for the purpose of tearing them down to widen the roadway.

The significance of the recommendations made in my report in November, 1922, that immediate provision should be made to fix the ultimate width of the right-of-way of the state highways and that studies should be made with a view to forecasting the amount and character of the probable future traffic, was to avoid similar situations such as exist in New York City and in practically all of the cities in the country today. The time to fix the ultimate width of the right-of-way of the highways, to provide for necessary widening to take care of future traffic demands, is before the land has become valuable and buildings have been constructed upon it. It simply means determining upon the state plan with respect to the ultimate width of the right-of-way of hignways through the state in a comprehensive manner, at a time when it is possible to do so at a minimum cost and inconvenience to the public.

The traffic survey being made in cooperation with the United States Department of Public Roads is furnishing the Pennsylvania Department with information through which it will be possible to estimate with some degree of accuracy the probable future traffic, and the character of that traffic, on every highway throughout the state. There are, of course, a number of highways that have very light traffic today that will become heavy traffic highways in the future—perhaps, 5, 10, 15, 20, 30 or more years from now, for which provision should be made.

This is the method that has been used by the steam railroads, the street rail-

ways, and public service corporations, and industries in general to forecast their future business. They purchase land in advance of the time they will actually need it, so they can expand as their business increases.

The same principle is applicable to the highways. It is simply good engineering business judgment to fix the ultimate width at this time so that it will be on the state plan, and the land will not be built upon, thus enabling the state to widen the roadways as the necessity arises. Under the law the Highway department has the right to fix the right-of-way of highways throughout the state at a width not exceeding 120 ft. The widths that will be fixed by the state will range from 50 ft. to 120 ft., depending upon the necessity from standpoint of the future traffic.

The width of the Lincoln Highway from Philadelphia to Paoli has been fixed at 80 ft., but this is an illustration of waiting too long before fixing the ultimate width. The width of this particular highway, which is one of the main arteries and one of the most important state highways in Pennsylvania, should be at least 100 ft. Owing to the fact that it is very largely built up for a greater part of the distance from Philadelphia to Paoli, and a greater width than 80 ft. would cause considerable damage to the property, the width has been fixed at 80 ft.

There are already numerous instances throughout the state where it will be impossible to arrange for the desirable width for highways passing through communities, because they are built up to such an extent that the cost of tearing down the buildings and acquiring the land would make it prohibitive at this time.

No one over twelve years of age can fail to see the necessity for attempting to make provision for the natural increases in traffic on state highways after observing the traffic conditions on city streets and highways throughout the country today. When it is perfectly obvious that the traffic has been increasing, and will continue to increase, to such an extent that it is inevitable that the highways must be widened, it becomes the duty of the highway engineer to plan a highway system that will be adequate to take care of not only the present, but the future traffic. The engineers in the Highway department have been making intensive studies for the past year with a view to laying out a comprehensive plan with respect to the width of the right-of-way of all the highways on the Pennsylvania State highway system.

There is hardly a city in the United States in which the people are not constantly expressing regret that their forefathers were not far-sighted enough to lay out the streets wide enough to take care of the traffic they are called upon to accommodate today. This, in a great many instances, is due to the fact that there was too much politics and too little engineering in making the city plan. The present comprehensive undertaking of the Pennsylvania Highway Department to obviate the mistake that has been made in so many of our cities to provide for future traffic requirements, will have the universal endorsement of engineers and business men throughout the country.

RESULTS OF RECENT IMPACT TESTS ON CONCRETE PAVEMENT SLABS

By Leslie W. Teller, Assistant Testing Engineer, U. S. Bureau of Public Roads, Washington, D. C.

(Editor's Note: The following introductory statement and summary of conclusions are from a very comprehensive article on this subject appearing in "Public Roads" for April, 1924.)

Continuing the study of the magnitude and effect of motor truck impact begun four years ago, the Bureau of Public Roads has recently completed a series of tests to determine the resistance of pavement slabs of various designs to impact of motor vehicles. Previous reports dealing with earlier phases of the investigation have announced the findings of the bureau with respect to the possible magnitude of the impact forces resulting from the operation of trucks over road surfaces of different degrees of roughness, the relative strength of such forces compared with the static weight of the vehicle, the effect of differences in tire and spring equipment and variations in sprung and unsprung load upon the character and intensity of the impact, and the effect of the impact upon a limited number of specially constructed slabs of various designs.

This report deals with the results of the tests of a second series of slabs more comprehensive in its range of types. As in the case of the previous reports, this

one deals with only one phase of the investigation which is being continued. The results reported are not entirely conclusive. They are to be regarded as sign boards which point the way rather than as a guaranty of safe arrival at the destination. If viewed thus broadly, it is felt that their publication will accomplish a useful purpose.

Some of the results are erratic and in the absence of check tests can not be explained, but in the main they are quite consistent. Some of the indications are apparent throughout the tests, while others do not show so clearly in the data, and in such cases careful observations made in the course of the tests and the knowledge of the investigators as to conditions which influenced the results of individual tests have been drawn upon as well as the recorded test data in forming the conclusions which are presented below.

Conclusions Drawn From the Tests

The exact nature of the tests must be borne in mind in applying the conclusions drawn from them to other conditions. The conclusions are stated in terms of maximum impacts delivered by the different weights of motor truck. Failure is assumed to have occurred when cracking takes place. The maximum impact values are such as would be expected under conditions of high speed and rough surface. Smoothness of the surface and suitable tire equipment will reduce the maximum impact pressures with a resulting higher load carrying capacity than that indicated by the tests.

The essential features of the tests involve:

(1) Specimens 7 ft. square laid on a moderately plastic clay subgrade, the wet portion having water standing almost level with the surface, the dry portion being merely damp with capillary moisture.

(2) Repeated impacts, increasing to the maximum which caused cracking applied at the corner and at the center of one edge by an impact machine dealing blows closely resembling impact of motor trucks. Rolling loads were not applied. No impacts were delivered at the centers of the slabs.

The conclusions drawn from the test are as follows:

The resistance of the road slab depends in part upon the supporting value of the subgrade. A subgrade of high supporting value materially increases the resistance to impact.

Impact resistance of rigid slabs varies neither directly as the depth of the slab nor as the square of the depth but as some power less than two.

In general, plain concrete slabs show no more resistance to impact delivered at the edge than to impact delivered at a corner.

Transverse cracks and longitudinal cracks near the sides of a road slab may be caused by impact delivered at the edge of the slab.

Plain concrete of 1:3:6 mix offers resistance to impact ranging from 60 per cent to 80 per cent of the resistance of plain concrete of 1:1½:3 mix. The lean mix also shows more variation in strength.

Effects of Reinforcing Steel

Reinforcing steel in concrete slabs, if present in sufficient amount and so placed as to receive tensile stress, adds to the resistance of the slab to impact.

Reinforcing steel placed longitudinally and transversely in equal percentages is more effective in preventing corner failures than the same amount placed in one direction.

For a given percentage of steel, small deformed rods closely spaced seem to be more effective than large deformed rods widely spaced.

There is very little evidence of cushioning by bituminous tops on concrete bases at temperatures of 90 deg. F. or less.

In these tests there was no evidence that bituminous tops on concrete bases added to the slab strength of the base, with the possible exception of the 4-in. and 6-in. bases on the dry subgrade.

Laid on the wet plastic subgrade none of the unreinforced slabs was capable of resisting impact at the edge or corner equivalent to that of a 5-ton truck; only the 8-in., 1:1½:3 slabs and the 2-in. Topeka tops on 8-in., 1:1½:3 bases resisted edge or corner impact equivalent to that of a 3-ton truck; all unreinforced slabs of lesser thickness failed under edge or corner impact less than that of a 2-ton truck.

Laid on a dry subgrade the 8-in. plain concrete slabs of 1:1½:3 mix and the 8-in. edge thickness, unreinforced, 1:1½:3 bases with 2-in. Topeka tops resisted edge and corner impact equivalent to that of a 5-ton truck was a safe margin; no other slabs were capable of resisting the 5-ton truck impact even under the favorable conditions of dry subgrade support. A section of 6-in. plain concrete base, 1:1½:3 mix,

with a 2-in. Topeka top resisted the edge impact of a 3-ton truck; no other slabs of lesser edge thickness, laid on the dry subgrade, were capable of resisting impact greater than that of a 2-ton truck.

None of the systems of steel reinforcing tested added sufficiently to the strength of a 6-in. 1:1½:3 concrete slab to enable it to resist the edge and corner impact of a 3-ton truck when the slab was supported by a very wet, plastic subgrade, nor to resist the edge or corner impact of a 5-ton truck when the slab was supported by a dry subgrade.

In some of the tests there was evidence that while the presence of the steel did not assist greatly in preventing the formation of the first crack it did prevent the development of the crack and the further failure of the slab.

COMPARISON OF COSTS OF TRACKLESS TROLLEY AND GASOLINE BUS AT TOLEDO

By W. E. Cann, Street Railway Commissioner, Toledo, Ohio.

(Editor's Note: The present article, prepared as a report to the Toledo City Council, is from the Toledo City Journal for March 1, 1924. Space will be provided in later issues for a discussion of this subject if correspondents so desire.)

As a result of a very careful study of both the gasoline bus and trackless trolley for the operation of a cross-town line, I beg to submit the following data as to investment cost, operating expense, and fixed charges on these two types of vehicles. These estimates are based on a proposed route, beginning at the intersection of Wayne and Fearing Streets, thence via Fearing, Detroit, Lawrence and Central to Stickney Ave., a distance of 5.5 miles.

In each case it is proposed to give a twelve minute service throughout the day, utilizing six vehicles, and for two hours, morning and evening, by the use of six additional vehicles, to give a seven minute service.

Investment

Gasoline Bus	
12 buses at $6,600 each	$ 78,200
Repair parts in stock	5,000
Garage	20,000
Total	$103,200
Trackless Trolley	
12 trackless trolleys at $9,000 each	$108,000
Overhead—5.5 miles at $5,000	27,500
Repair parts in stock	2,000
Garage	20,000
Total	$157,500

Operating Expense and Fixed Charges

	Gas Bus Cents	Trackless Cents
Conducting Transportation	10.31	10.31
Maintenance	10.41	7.00
General and Miscellaneous	3.44	3.44
Gas or Power	3.80	2.00
Lubrication	.75	.01
Depreciation	4.16	3.69
Taxes	.55	.85
City Purchase Fund	.63	.98
Interest on Investment	2.02	3.16
Total cost per car mile	36.08	29.44

You will note from the above that the investment for gasoline bus service amounts to $103,200 and for the trackless trolley $157,500. I believe that the figures covering the operating expense and fixed charges are conservative and as accurate as can be secured with the limited data on trackless trolleys at the present time available. The figures on gasoline bus operation are taken from actual experience in other cities and with the proper corrections made to meet conditions in the City of Toledo. The final results compare very favorably with actual results obtained in Akron of 37.07c; Baltimore, 35.08c; and Boston, 36.30c per car mile. The trackless trolley has not been in operation sufficiently long to provide any reliable operating costs, and in the figures set forth above I believe that the estimates of the various items entering into the total cost have been placed sufficiently high to be well on the safe side.

Trolleys Last Many Years

In the matter of maintenance, I have taken the maintenance figure for electric street cars and added 50 per cent, despite the fact that a street car weighs approximately three times as much as a trackless trolley. Also, for trolley maintenance due to the extra trolley wire, I have added 100 per cent to the present trolley maintenance figures.

In the matter of depreciation, I have used a 5 year basis for gasoline buses, a 10 year basis for trolley wire and trackless trolley vehicles, and, in each case, a 20 year basis for depreciation of the garage. Considering that it is a matter of record that street cars are today operating in several American cities after more than 30 years' life and are still using the original motor, I believe that you will concede that my 10 year basis for depreciating this vehicle is overly conservative.

Difference Favors Trackless Trolley

You will note that the total cost of operation and fixed charges on the gasoline bus aggregates 36.08c per bus mile and for the trackless trolley 29.44c, a

difference of 6.64c which applied to the probable 400,000 miles of operation on this cross-town route would represent a total saving in favor of the trackless trolley of $26,560 per annum.

The Hawley Street route, as proposed by the City Plan Commission, would traverse the following streets: from Broadway via Thayer, South, Hawley, Hoag, Detroit, Lawrence and Central to Stickney, a distance of 5.95 miles. This route if adopted, and the trackless trolley used, would require the construction of 0.45 miles additional overhead wires at a cost of $2,250, and would add to the operating expense 0.06c per car mile. Because of the additional distance, it would be necessary to provide more running time. This would reduce the headway to 15 minutes during the day and 8 minutes during the rush hours. The annual mileage operated would be the same over each route.

Trolleys Provide Comforts

There are other elements incident to trackless trolley operation which I believe would be well for you to seriously consider. Where gasoline buses are operated, I have very frequently noticed complaint due to obnoxious fumes, which escape from the exhaust pipe heating system. This condition is entirely obviated in the trackless trolley by the use of electric heaters. Lighting in the gasoline buses is provided for by storage batteries. The ordinary equipment furnished for this purpose is inadequate and an additional battery has to be installed and maintained. In the trackless trolley, power for light is taken direct from the trolley wire and, as a result, it is possible to have a brilliantly lighted vehicle at all times.

While gasoline buses are frequently out of service due to leaky radiators, improper lubrication, valve and spark plug trouble, etc., these troubles are not encountered with the trackless trolley, nor is there any difficulty with the latter vehicle freezing up during extremely cold weather.

From a standpoint of comfort to the passenger the trackless trolley is far superior to the gasoline vehicle, due to the fact that there is no vibration and the electric motor starts without the severe jerk that is encountered with the gasoline engine, particularly after it has been in service for a short time.

In conclusion, let me call your attention to the fact that over certain portions of this route the pavements are in such bad condition as to materially affect the life of either type of vehicle operating over the route. I believe it would be to the economic interest of the car rider, and certainly to his comfort, if your honorable body would take the necessary steps to have these pavements repaired and put in usable condition.

EXPERIENCE WITH "BLACK BASE" CONSTRUCTION IN MERCER COUNTY, N. J.

By H. F. Harris, Mercer County Engineer.

During the season of 1922 the Engineering Department of Mercer County, New Jersey, was called upon to construct a short length of highway connecting two important improved roads. Upon this highway for almost the entire length there was erected on both sides a large industrial plant, the operators of which were called upon daily to ship by rail large tonnages of their product. It was required that this product should be hauled by horse-drawn trucks a distance of one-half mile to the nearest freight station.

Reasons for Adopting Black Base

In considering the design for the proposed pavement, the engineers of the County felt that a substantial foundation was one of the first requisites to a proper and suitable pavement.

The existing road had been spasmodically covered with a scant coating of macadam which was so badly rutted and pot-holed that it was with much difficulty that the street could be "navigated" at all.

Frankly, the engineers were in a quandary as to what would be the proper type of pavement to select and the best method of constructing a substantial and durable foundation for comparatively heavy traffic without seriously crippling the daily output of the plant, as it was impossible in any way to detour the traffic from the plant by any other outlet than the one which entered upon the street, and it was out of the question to shut off traffic for a period of from two to three weeks, should it be desired to construct the usual 6-in. Portland cement concrete foundation. Moreover, the scanty depth of the existing stone, as well as its elevation above the curb grade, precluded its use as a first class foundation.

They finally conceived the idea of constructing a so-called "black base" pavement, on a sub-foundation of stone, which

stone was taken from the excavated material and topping the "black base" with the regular standard sheet asphalt pavement 1½-ins. thick.

Construction Methods

The general method followed in constructing this foundation was to remove the existing stone with forks and cast it into piles, then excavate to 3 ins. below the grade fixed for the bottom of the "black base", replace the stone, which was then rolled and bound up in a similar manner to the ordinary macadam road, with the exception that no unusual effort was made to obtain particularly clean stone. There were two reasons for using this stone sub-base; first, it would have been impossible to have rolled the heavy sandy soil without the addition of some such material; second, it was felt that it would be advisable to provide ample depth of foundation for type of road so far untried in Mercer County.

After this had been properly shaped, sprinkled, rolled and compacted, the hot mixed "black base" foundation was applied in a manner similar to the ordinary asphalt binder course, except that it was constructed in two layers, each 3 ins. thick after it had been thoroughly rolled, which operation a 1½-in. asphalt pavement was applied for the finish; this construction making a pavement having a total thickness of 10½ ins. The "black base" was constructed in two layers in order to obtain the greatest amount of compression.

The maximum length of time that traffic was suspended from the industrial plant after following out this scheme of operation, was but four hours, showing an economic saving in time of very considerable proportions, both to the plant owners and the general public.

Cost Analysis

The cost analysis per square yard on the basis of the low bid for this work follows:

Excavation	$0.49
3-in. Stone sub-foundation	0.18
6-in. Black Base	2.49
1½-in. Sheet Asphalt Surface	0.89
Total	$4.05

The cost was about 11 per cent below the Engineer's estimate, and it is believed that with a larger volume of work and with contractors getting more familiar with the type of construction that the cost can be materially reduced. For the contractor it eliminates entirely the necessity of bringing in a concreting outfit.

Analysis of Asphaltic Material

The following typical analysis of the "black base" might be of interest:

Bitumen		6 %
Passing 200 Mesh		2.7%
Passing 100 Mesh,	4.2%	
Passing 80 Mesh,	2.2%	
Passing 50 Mesh,	4.9%	
Passing 40 Mesh,	3.2%	
Passing 30 Mesh,	2.6%	27.1%
Passing 20 Mesh,	3.6%	
Passing 10 Mesh,	4. %	
Passing ¼ Mesh,	2.4%	
Passing ½ Mesh	7.4%	
Passing ¾ Mesh	27.6%	
Passing 1 Mesh	23.4%	64.2%
Passing 1¼ Mesh	5.8%	
		100 %

A typical analysis of the asphaltic cement used follows:

Penetration of A. C.	46 %
Fixed Carbon	15.3 %
Mineral Matter	.05%
Organic Matter Insoluble	.05%
Bitumen	99.9 %
Total	100%

The laboratory and plant inspection for this work was under the supervision of Dow and Smith, and the work was constructed by James J. Barrett, superintended by M. P. Quinn, and the engineering for the County was in charge of J. B. Walker.

While the total length constructed is comparatively short, it is believed that it is of sufficient area to demonstrate the possibilities of this type of construction, the greatest saving being in the amount of time which was saved during the operation.

Reconstructing a Stone Road

The possibilities for time saving were well demonstrated the following year, when it was planned to reconstruct entirely a section of stone road approximately two miles in length. This job was planned and undertaken as a result of the previous year's experience.

In order to determine the exact width and depth of the old stone, the road was stationed off in 100 ft. sections. Three measurements were made at each section; one at the crown and one at each of the edges. At all of these points the depth of stone was recorded, and also the width of the original stone road.

As the old road had been treated four or five years in succession with hot asphaltic surface oil, a very heavy mat had been built up on the road. It was found that this mat had accumulated to a depth of considerably over an inch. In many places it even approached a depth of 3 ins. With a mat in this condition, it was impossible to continue the oil treatment,

and traffic was increasing to such an extent that it was felt that a stone road was no longer adequate to meet the traffic demands, since the road in question formed a thru truck route between New York and Philadelphia and connected directly with the free bridge over the Delaware River.

Measurements taken at the 100-ft. stations previous to the actual design of the road, showed that the average width of the stone throughout the entire distance was 16.7 ft., the minimum being 15.1 ft. and the maximum 18.9 ft. The depth of stone averaged 8¾ ins., the minimum being 5½ ins. and the maximum 13 ins., too large an investment to disregard.

Advantages of Reconstruction

After studying this situation carefully, it was decided to make use of this depth of stone as a foundation, widen it out where required, and build up additional thickness for foundation with "black base" construction, as in this case curbs or sidewalks had not been constructed, nor had grades for them been established. This idea had numerous advantages over other plans studied:

1. It would enable the authorities to construct a modern pavement in a minimum length of time.
2. It would give a thicker and heavier pavement.
3. Considering width and depth and the economy in time, it could be constructed at much less cost.
4. It would also conserve the investment in the original pavement to the uttermost, and there would be a minimum of inconvenience to abutting property owners.
5. Openings for extension of sewers, water and gas mains could be more quickly made and repaired.

The final plans called for constructing an asphalt surface 20 ft. wide with 3 ft. penetration shoulders on either side. The time allotted in the contract for completing the work was 121 days, Sundays and holidays included. The time in which the work was actually constructed was 71 days, making a difference of 50 days, for which the contractor earned a bonus of $500. Two miles of road were therefore entirely rebuilt in 71 days elapsed time. In the work also was included about $7,000 worth of drainage pipes and other structures.

Cost Data

For constructing the sheet asphalt pavement 20 ft. wide on a square yard basis the costs were as follows:

Excavation (for widening foundation)	$0.147
Widening macadam foundation with stone, including the scarifying and removal of old oil mat	0.755
Black Base, 304 lbs. per sq. yd.	1.355
Sheet asphalt surface, 1½ inches deep	1.49
Total cost	$3.747

The penetration macadam shoulders cost per square yard as follows:

Excavation	$0.147
Foundation, 8-in. waterbound macadam	0.755
Penetration macadam surface, 3 inches deep	1.35
Total cost	$2.252

It will be noted that the cost of the penetration macadam surface 3 ins. deep, was almost exactly the same as for laying the "black base," that is, $1.35, the "black base" having averaged 3 ins. in depth. In many places, however, the "black base" had a maximum depth of over 4 ins., due to making up inequalities in the old stone base.

The Engineer's preliminary estimate of cost for this work was $104,740. After advertising for bids the following three lump sum proposals were received:

Bidder A	$102,309.70
Bidder B	104,641.50
Bidder C	132,171.50

Unit prices were received for all items of construction. The award price for black base mix per ton was $8.90 in place. Two and one-half inch (2½-in.) stone screenings in place, $3.25 per ton; excavation without classification, $1.70 per cubic yard. The analyzed cost figures previously given for all items on a per square yard basis were equated from the per ton figures named in the bid.

In widening the roadway proper, the work of constructing the foundation for the penetration shoulders was included and performed as one operation. In this way it was possible thoroughly to roll and secure a well consolidated base, and eliminate a line of weakness which is often found at the point where the pavement joins the newly constructed shoulders. If the penetration shoulder is built after the laying of the surface pavement, as is often the case, it is very difficult to roll and consolidate stone in a trench only 3 ft. wide or to bond and tie it into the old road.

This work was also constructed by James J. Barrett, and the asphalt work both at the plant and at the laboratory was inspected by Stillman and Van Siclen. The engineering was in charge of Mr. J. B. Walker.

Performance

It might be of interest to point out that immediately adjoining the first described work there is a stretch of about one mile of 20-ft.-wide sheet asphalt pavement of standard construction, built on a Portland cement concrete foundation. This work was laid two years earlier and is also in very excellent condition. The only defects perceptible now are a series of transverse cracks at regular or fairly regular intervals, undoubtedly due to cracks in the base. These became quite apparent between the second and third year in the life of the pavement and observation and comparison of the behavior of these two pavements immediately adjacent to one another is going to be an interesting field for study.

Up to the present time the "black base" work has shown no cracks whatever, and is to all intents and purposes in every respect equal to the standard practice in constructing sheet asphalt with the rigid base.

SUCCESSFUL TRIAL OF WHITE JOINT FILLER FOR CONCRETE ROAD CRACKS

By L. G. Carmick, Chemist, U. S. Bureau of Public Roads, Washington, D. C.

Two years' trial of a light-colored material developed by the Bureau of Public Roads for use as a filler for joints and cracks in concrete roads has demonstrated that the material has qualities which make it decidedly valuable for the purpose. Considering the lasting qualities of the material it has also been demonstrated that it is certainly not much more costly than other fillers, and it is possible that it will be found to be no more expensive.

In the early part of 1922 the Bureau of Public Roads began a search for some material of about the same color as Portland cement concrete that could be used for filling cracks and expansion joints in concrete roads. The bituminous materials which have always been used for this purpose are considered fairly satisfactory in most respects, but they unquestionably disfigure the road. A large number of different substances were experimented with and abandoned, which it is not worth while to mention here. However, after numerous failures a plastic material was found which seems to have most of the desired qualities.

Character of the Material

It is an intimate mixture of crude unvulcanized rubber with rosin in the proportion of one part of rubber to about ten of rosin, to which mixture is added a considerable quantity of a neutral white pigment, preferably barytes or titanox. Some difficulty was experienced at first in securing a homogeneous mixture of these materials, as rubber does not dissolve readily in melted rosin. But, eventually it was found that if the rubber were softened by allowing it to absorb about twice its weight of a light petroleum lubricating oil, and the mixture effected in a steam-jacketed iron vessel provided with revolving arms which exerted a mixing and kneading action, a smooth product could be obtained.

This material differs in many respects from tar and asphalt. In color it is almost white, but it can be readily tinted to any desired shade. It is extremely sticky, especially when hot, and has a high degree of ductility. In these respects it resembles bituminous materials, but it is far less affected by temperature changes. It is more difficult to melt and even in the coldest winter weather met with in the vicinity of Washington it does not become brittle.

Use of Material

To use this material successfully these facts must be borne in mind. It may be melted in open kettles at the roadside, but the melting takes longer than with bitumens and care should be taken to prevent the material from catching fire and to avoid overheating. At a temperature of about 110 to 120 deg. C. it is fluid enough to pour, and it does not become much more fluid even though the temperature be considerably raised, but the quality of the material is injuriously affected if heated much above this temperature. It was also found that it did not flow to the bottom of the cracks as readily as bituminous fillers, but this was overcome by the use of a hot iron implement, with which it can be worked down into even very narrow cracks. The tool used at present somewhat resembles a laundry iron, but with a handle long enough to enable a man to use it without stooping uncomfortably. Two of these are necessary, one being heated while the other is in use. Aso soon as the material is poured into the crack it is gone over with the hot iron and in this way very good results are obtained.

Behavior And Cost of Filler

This crack filler has been used experimentally in several of the States and the

reports have been generally favorable. It has also been used in the Columbia Pike, an experimental road constructed by the Bureau of Public Roads near Washington. Frequent inspections of the material as used in this road, and comparison with the several types of bituminous fillers also used provide the basis for the statements made in this article. On the Columbia Pike the cracks were filled with the new material in December, 1922. A recent inspection shows them to be in good condition still. The cracks are well filled and the material has shown no tendency to flow out or "bleed." Traffic has done it no harm. The cracks that were filled after the men had learned how to handle the material are particularly good. They are inconspicuous and, in some cases, almost invisible. Cracks that were filled at the same time with asphalt had to be filled again in September, 1923, and are now badly in need of further attention. The asphalt flows out, causing an unsightly black streak in many cases several inches wide on each side of the crack.

Cost of Filler

This light-colored crack filler costs at present about 10 cts. per pound which is, of course, much more than asphalt or tar, and furthermore it is not likely that its cost can be very greatly reduced. Also the labor cost of applying it is somewhat more than for asphalt and it was accepted as a fact in the beginning that it could not compete in price with bituminous fillers. Its use was felt justified, however, because in any case it would be a very small item in the cost of a first-class concrete highway, and the finer appearance of the road, due to the absence of black streaks was considered to be worth the additional cost.

However, in view of recent inspections it seems that its cost, taken over a period of years may not be so much greater than asphalt after all. For instance, cost data on the road mentioned show that filling cracks with asphalt cost $0.0075 per square yard of road for labor and material. The cost of the light-colored filler was about 1 cent per square yard for material and 1¼ cts. for labor, the total being about three times as much as for asphalt. It is, therefore, apparent that if the light-colored material lasts three times as long as asphalt it will entail no greater expense. Experience so far seems to indicate that this will be the case.

The foregoing article by Mr. Carmick is from May, 1924, Public Roads.

DATA ON CARRYING CAPACITIES OF PIPE CULVERTS

(Editor's Note: A correspondent, who refers to the interesting letters of Mr. C. E. De Leuw and Prof. Floyd A. Nagler on hydraulic factors in culvert design, published in recent issues of Municipal and County Engineering, calls our attention to an article in the March, 1924, issue of Public Roads, issued by the U. S. Department of Agriculture, Bureau of Public Roads, entitled: "The Flow of Water Through Pipe Culverts." The conclusions of that article are presented herewith. This study is a comparison of concrete, vitrified clay and corrugated metal pipes with respect to their carrying capacity when installed in culverts. The investigation was conducted by the U. S. Bureau of Public Roads and the State University of Iowa at Iowa City under the direction of D. L. Yarnell, Senior Drainage Engineer of the U. S. Bureau of Public Roads and Prof. S. S. Woodward and Floyd A. Nagler of the State University of Iowa. This investigation has been under way for over 18 months.)

The average values of co-efficient of roughness in concrete, vitrified clay and corrugated metal culvert pipes are as shown in the accompanying table:

Diam. of pipe	KUTTER COEFFICIENT			MANNING COEFFICIENT		
Inches	Concrete	Clay	Metal	Concrete	Clay	Metal
12	0.0117	0.0101	0.0194	0.0119	0.0098	0.0228
18	.0121	.0119	.0217	.0121	.0118	.0248
24	.0130	.0127	.0216	.0130	.0125	.0239
30	.0127	.0131	.0232	.0125	.0131	.0254

It is to be concluded from the investigations that the capacity for the same diameter of pipe of vitrified clay culverts exceeds those constructed of cement concrete pipe approximately 10 per cent.

Conclusions

In addition to the above the investigators present a series of conclusions a part of which are given herewith:

1. The discharging capacity of a pipe culvert depends primarily upon the cross section of the pipe and the difference in water level at the two ends of the culvert.

2. To obtain the maximum discharge, the pipe must be so laid as to insure the full cross section of the pipe being filled by the flowing water.

3. If the pipe is laid at too high an elevation with respect to the water levels at the two ends of the culvert, it will not

run full and hence will not attain its maximum capacity.

4. If a culvert pipe is so laid that both its upstream and downstream ends are completely submerged the amount of water which it discharges will be proportional to the square root of the difference in water level at the two ends, and the exact grade at which the culvert pipe is laid has no effect whatever upon its maximum discharging capacity.

5. The coefficient of roughness "N" in the Kutter formula for concrete pipe ranges from 0.012 for the 12-in. size to 0.013 for the 30-in. size.

6. The coefficient of roughness "N" in the Kutter formula for vitrified clay pipe ranges from 0.010 for the 12-in. size to 0.013 for the 30-in. size.

7. The coefficient of roughness "N" in the Kutter formula for corrugated metal pipe ranges from 0.019 for the 12-in. size to 0.023 for the 30-in. size.

8. In concrete, vitrified clay, and corrugated metal pipe culverts, 30.6 ft. long, with straight end wall entrances:

(a) The 12-in. concrete pipe with beveled-lip end upstream will carry about 49 per cent more water than the 12-in. metal pipe.

(b) The 18-in. concrete pipe with beveled-lip end upstream will carry about 40 per cent more water than the 18-in. metal pipe.

(c) The 24-in. concrete pipe with beveled-lip end upstream will carry about 36 per cent more water than the 24-in. metal pipe.

(d) The 30-in. concrete pipe with beveled-lip end upstream will carry about 32 per cent more water than the 30-in. metal pipe.

(e) The 12-in. clay pipe will carry about 65 per cent more water than the 12-in. metal pipe.

(f) The 18-in. clay pipe will carry about 50 per cent more water than the 18-in. metal pipe.

(g) The 24-in. clay pipe will carry about 40 per cent more water than the 24-in. metal pipe.

(h) The 30-in. clay pipe will carry about 30 per cent more water than the 30-in. metal pipe.

9. In concrete pipe culverts, 30.6 ft. long, with straight end wall entrances.

(a) The 12-in. pipe with beveled-lip end upstream will carry about 5 per cent more water than the same pipe with a square-cornered entrance.

(b) The 18-in. pipe with beveled-lip end upstream will carry about 9 per cent more water than the same pipe with a square-cornered entrance.

(c) The 24-in. pipe with beveled-lip end upstream will carry about 12 per cent more water than the same pipe with a square-cornered entrance.

(d) The 30-in. pipe with beveled-lip end upstream will carry about 14 per cent more water than the same pipe with a square-cornered entrance.

10. The effect of the length of the culvert on the discharge is not as great with concrete and vitrified clay pipe as with corrugated metal pipe.

11. The 45 deg. wing walls used in connection with a corrugated metal pipe culvert will increase the capacity from 1 to 10 per cent over that obtained in a metal pipe culvert with a straight end wall.

12. The 45 deg. wing walls used in connection with a corrugated metal pipe culvert are more efficient when set flush with the edge of the pipe than when set 6 ins. back from the edge of the pipe.

13. The 45 deg. wing walls used in connection with a corrugated metal pipe culvert are more efficient when built full height to the top of the head wall than when constructed standard height.

14. The 45 deg. wing walls used in connection with a vitrified clay pipe culvert are not as effective as the straight end wall entrance with the regular bell end upstream.

15. The U-type wings used in connection with a vitrified clay pipe culvert are not as effective as the straight end wall.

16. The beveled-lip end at the entrance of a concrete pipe culvert is a great aid in reducing the entrance loss, especially in the larger sizes.

17. The bell end at the entrance of vitrified clay pipe culvert by virtue of its shape assists greatly in reducing the entrance loss, especially in the small sizes.

18. A 24-in. clay pipe culvert, 38 ft. long, with a straight end wall and the regular bell end upstream will carry about 10 per cent more water than the same culvert with a square-cornered entrance.

19. By merely rounding the entrance to a 24-in. vitrified clay pipe culvert the capacity may be increased approximately 13 per cent over that obtained with a square-cornered entrance.

20. By projecting the pipe through the head wall so as to obtain the effect of no head wall on the discharge, it was found that:

(a) In the 12-in. concrete pipe culvert having a square-cornered entrance, there was little difference, whether the pipe projected 3 ins. or 4 ft. beyond the head wall.

(b) The discharge is decreased slightly by projecting the pipe through the head wall when compared to the same culvert with a straight end wall entrance.

(c) The 18-in. corrugated metal with a 3-in. projection beyond the head wall carried slightly more water than the same pipe with either a 2-ft. or a 4-ft. projection.

(d) The 18-in. metal pipe with a straight end wall entrance will carry more water than the same pipe with any length of projection.

21. By increasing the area of the cross-section of the outlet end of the pipe culvert so that the area ratio is about 1 to 2, and the angle of divergence about 10 deg. the discharge of the culvert, when the outlet is submerged, may be increased 40 per cent over that obtained in the same culvert having a uniform bore throughout.

OVER-CHLORINATION OF WATER FOR TASTE CONTROL

By W. B. Bushnell, Superwising Engineer, Champaign and Urbana Water Co., Champaign, Ill.

The purpose of this paper is not to discuss the theory of over-chlorination, but to furnish a history of a single experience of the Champaign & Urbana Water Co.

We have a covered clear water reservoir which, at periods of the year is a breeding place for gnats that lay eggs that hatch into red worms, which in turn develop into gnats, which gnats lay more eggs, etc., etc. While these worms are not harmful to the health, they are a decidedly disagreeable adulteration of an otherwise pleasant water and our consumers have a way of objecting to them when they appear in their drinking glass. We have been much concerned by this difficulty, have put into effect several plans suggested by different authorities and tried out ideas of our own, hoping to end the invasion of these red worms.

Our last effort was made last September. A short time previously we had taken out glass windows in the reservoir roof and made it light tight and thought if the worms and gnats were once entirely removed they would not reappear. On Sept. 4, 1923, we admitted 20 lbs. of free chlorine into our 750,000-gal. reservoir. We hoped that this would kill the gnats. Our efforts were successful. We killed the gnats, and from the taste that appeared the following morning in the water we were under the impression that we had killed almost everything else in the universe and that it had in some mysterious manner found entrance into our mains. This taste continued, being at its worst between Sept. 8 and 14. We were of the opinion that there had been some chrenothrix in our mains and that the extra dosage of chlorine had killed this, thus producing the taste, and that it would be only a question of a short time before this would disappear. However, it had not materially disappeared on September 18, at which time we increased our regular dosage of chlorine into the influent of our filters from 15 lbs. to 20 lbs. per day. The following morning the taste in the water was noticeably diminished and in a short time entirely eliminated. At this time our chlorinator was equipped with an orifice tube of 20 lbs. per day maximum capacity. On Oct. 1, 1923, a new orifice tube was installed of maximum capacity of 80 lbs. per day. For a few days following this we fed chlorine into the wash water at the rate of 50 lbs. per day for the purpose of sterilizing our filter beds. We still continue the dosage into our filter influent at the rate of 20 lbs. per day and have had no recurrence of the taste. The daily pumpage is 2,500,000 gals. We have had no more gnats in the reservoir but the real test in this regard will come in the spring, as they do not appear during the winter months.

The foregoing paper by Mr. Bushnell was presented at the recent meeting of the Illinois Section of the American Waterworks Association.

REASONS FOR RAILWAY CONSOLIDATION

(Editor's Note: The following is an extract from the annual report of Herbert Hoover, Secretary of Commerce.)

The past year's experience of the department in its relations to transportation has shown even more emphatically than ever before the necessity for the consolidation of the railways into larger systems under private ownership, the principles of which were established in the transportation act of 1920.

The difficulties of reorganizing the rate structure so as to secure simplification and to give relief in primary products—agricultural, coal, etc.—by a fairer burden upon finished and LCL goods are almost insuperable until the different systems are possessed of more diversified traffic and until the weaker roads have been absorbed. The necessity to establish railway credit and finance on a broader foundation than sole reliance upon the issue of mortgage securities; the necessity of provision for common utilization of terminal and other facilities; the impossibility of providing adequate rolling stock and particularly specialized cars so long as the burden falls solely upon the strong roads; the difficulties of more definite control of car service to meet seasonal demands and routing, the insuperable problems of equalization in car interchange; the slow progress in standardization and maintenance of equipment—all point to the imminent desirability of early progress with consolidations, if we are to have a transportation system adequate to the necessities of the country and containing in itself the strength for annual increase.

The policy of control of rates is fixed by National and State legislation. This policy has superseded the theory that reasonable rates are to be obtained through competitive action. The idea of protection against excessive rates through the maintenance of competition is now dead. We should therefore secure the largest possible benefits from consolidation into larger systems by securing consolidation in such fashion as will protect and advance public interest.

The urgent importance of the early consummation of consolidation warrants consideration of methods to expedite it. Under the present provisions for wholly voluntary action subject to the Interstate Commerce Commission, many consolidations are likely to be long delayed. The difficulties of negotiation between the members of the groups that will be established by the Interstate Commerce Commission; the complications arising from varying priorities of securities affecting the determination of terms of purchase by one railway line of the property of another; the unwillingness of some lines to acquire or to sell others; the questions of individuality; the difficulties of establishing by negotiation the relative value of one property to another; the necessity of holding capitalization within the limits of the actual property values; the complexities and conflicts of State regulation and laws—all these problems would find a great measure of solution if the consolidated systems were allowed Federal incorporation and if after a lapse of some appropriate period for voluntary action the Interstate Commerce Commission were given authority to create definite organization committees for each system including representation from the public and from the component roads. It should be the duty of such committees to develop and perfect a plan of consolidation either through the exchange of securities of the consolidated systems directly with the security holders of the component roads or by some other method. I believe that under such auspices the security holders would be willing voluntarily to make such an exchange. If a minority should refuse, it would be entirely feasible to invoke condemnation and purchase of their securities for the consolidated systems at an established fair value. Such a method would permit the determination of the relative value of the different railways considering both the physical properties and the often lower total of their securities, and due account could be taken of future as well as present conditions.

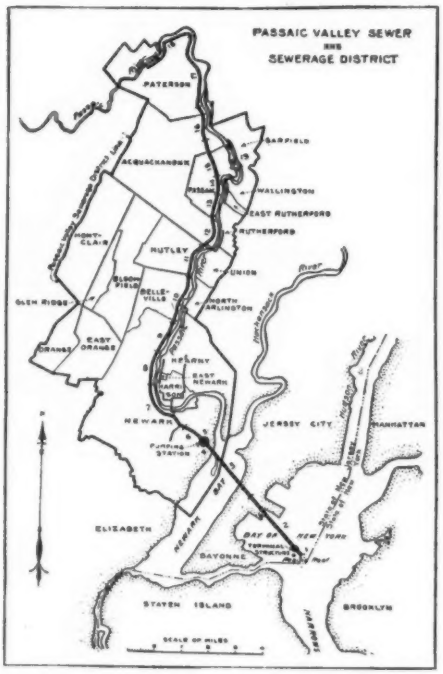
The ownership of some roads or terminals jointly by two or more consolidated systems could be provided for, as there are cases where such a solution would be most advisable in creating more efficient transportation. The public interest could be safeguarded by limiting the total capitalization of consolidated systems to an amount not exceeding the physical value of the railways as determined by the Interstate Commerce Commission under the transportation act as of June 30, 1914, plus actual capital expenditures and deducting abandonments and depreciation since that date. The total capitalization of many of the consolidated railways would probably be less than the Interstate Commerce Commission physical valuation and certainly less than their present nominal capital. An approach to the problem through such organization committees is in accord with common business practice, and if it were made possible it should result in greatly expediting consolidations and in their perfection on terms soundly protective of public interest and with an equitable adjustment of relative values between the component roads.

COMPLETION OF PASSAIC VALLEY SEWER

By Ralph Van Duyne, Chief Engineer, Passaic Valley Sewerage Commission, Newark, N. J.

The Passiac Valley sewerage problem is one of long standing in the district. As far back as 1896 the seriously polluted condition of the river was realized, and in that year the Legislature passed an act creating a commission to study the conditions and recommend a general system of sewage disposel for the relief of Passaic Valley.

The first plan considered was the construction of an intercepting sewer to discharge the untreated sewage of the district into Newark Bay. The next plan con-templated the treatment of the sewage at a disposal plant on the Newark meadows and the discharge of the effluent into Newark Bay.



MAP OF PASSAIC VALLEY SEWER AND SEWERAGE DISTRICT.

This plan was submitted to Messrs. Hering, Croes and Brown, sanitary engineers, who recommended, under date of December 2, 1901, that the sewage should be conveyed to a point of discharge in New York Bay.

Thereupon, laws were passed in 1902 creating the Passaic Valley sewerage district, defining its boundaries and arranging for the appointment of sewerage commissioners for the district.

In 1903 there followed an act by which the Passaic Valley Sewerage Commissioners were given full authority to construct and operate an intercepting sewer to receive the sewage of the Passaic Valley District and discharge the same into the water of New York Bay within the limits of the State of New Jersey.

Litigation Delayed Project

It then appeared as if the purification of the waters of the Passaic River would speedily be accomplished. Unfortunately, however, litigation ensued which finally resulted in the Court of Errors and Appeals declaring the Act of 1903 to be unconstitutional and inoperative so far as the construction of the sewer was concerned. This final decision was rendered in March, 1905.

For the next two years no further action was taken, but in 1907 the Legislature passed the act under which the Commissioners are now operating. This act provided for the construction of the sewer under contract by such of the municipalities in the district as might elect so to do. Again litigation arose—this time by the State of New York, to prevent the discharge of the sewage into the waters of New York Bay. This litigation assumed importance by reason of the fact that the United States authorities intervened on behalf of the complainant, and, inasmuch as it was necessary to secure the consent of the authorities of the United States for the discharge of the sewage into New York Bay, that intervention threatened the failure of the project.

Opposition Finally Withdrawn

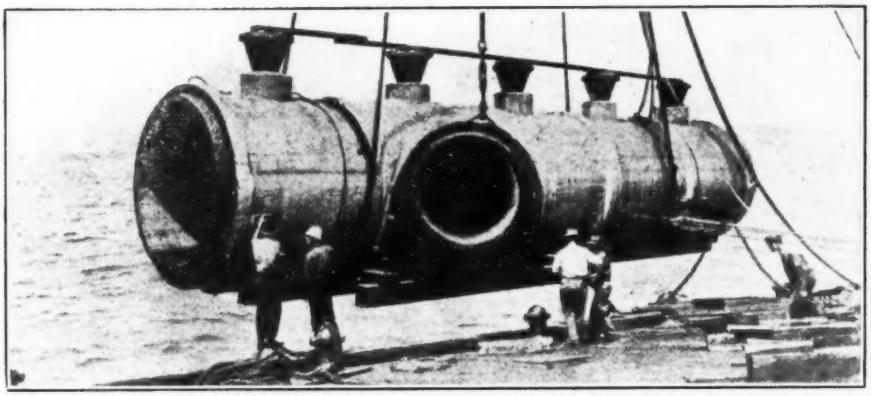
It was not until 1910 that the intervention of the United States was withdrawn and the necessary consent of the Federal authorities secured, and not until September, 1911, that 15 of the 20 municipalities within the Passaic Valley Sewerage District executed the contract under which the sewer is now being constructed. So much for the early history of the project.

The Passaic Valley Sewerage Works consist, in general, of a system of main sewers designed to intercept the sewage from the local sewage outlets in each municipality and finally to discharge the sewage at the pumping station, near Newark Bay, where the grit, sand and coarser floating matters are removed and the sewage pumped into basins for subsidence and treatment.

The clarified effluent from the basins is drawn off and discharged into a shaft

and tunnel leading beneath Newark Bay and a portion of Jersey City and New York Bay to a point off Robbins Reef, distant more than two miles from the shore, where the effluent is thoroughly diffused at a depth of more than 40 ft. into strong tidal currents.

Beginning in the City of Paterson, at a point just below the Great Falls, the main intercepting sewer receives the flow from two local sewerage districts. At this, its uppermost extremity, the main sewer has a diameter of 45 ins. The sewer traverses the City of Paterson for a distance of six miles, being located in the most part along the right bank of the Passiac river, and running through the public streets and private property. At the lower Paterson city line, the main intercepting sewer is 81 ins. in diameter, and has a normal capacity of 64 mgd. The sewer continues through Acquackanonk, Passaic, Nutley, Belleville and Newark, to the pumping station, a total distance of 21 miles, with steadily increasing diameter. At Third River, just below Passaic, a 120-in. sewer has been built, with a daily capacity of 140 mg. When Second River, the northerly boundary of Newark is reached the sewer has been increased to 126-in. and a daily capacity of 161 mgd. From the lower end of Newark to the pumping station on the Newark meadows, the sewer is 150 ins. in diameter, and the normal daily capacity is 303 mg.



SECTION OF OUTFALL PIPE OF PASSAIC VALLEY SEWER.
These sections are constructed of heavy reinforced concrete and have an outside diameter of 8 ft. Each section is 50 ft. long and weighs 65 tons.

Five Miles Through Tunnels

Of this 21 miles of main intercepting sewer, 5 miles have been constructed in tunnel and 16 in open trench excavations. Compressed air methods were used throughout most of the tunnel work, although short lengths of sewer were built in Passaic and Paterson under free-air tunnel methods.

Through the closely built-up portions of Newark, from Third Avenue to Avenue L, a distance of 3.3 miles where the street traffic is very heavy, the sewer was built entirely through the use of compressed air. The work was executed from five tunnel shafts and a working air pressure varying from 7 to 15 lbs. per sq. in., was employed in this sewer which has a maximum diameter of 12 ft. Light structural steel revetment plates formed to the exterior diameter of the masonry lining, were used in the tunnel headings. The steel plates, 3 ft. by 3 ft. in size, were bolted together, forming arcs extending over three-fourths of the circumference, each row of plates being bolted to the preceding row. All compressed air tunnels were circular in cross-section and lined with from 12-in. to 18-in. of rich concrete, depending on their diameters.

Sewers in open trench were also constructed of concrete masonry of substantial cross-section. The smaller sewers—those up to 4 ft. in diameter, were built with a circular interior cross-section, while all larger sewers are horseshoe in shape with curved inverts and semi-elliptical arches.

Many Branch Sewers Required

Nine of the 21 contracting municipalities are located on the opposite side of the river from the main intercepting sewer, In order to intercept the sewage from these nine communities, it was necessary to build some 13 miles of branch sewers, ranging from 15 ins. to 17 ins. in diameter and nine river crossings to conect these

branch sewers on one side of the river with the main intercepting sewer on the other. These river crossings, in every instance but one, which was a compressed air tunnel, consist of cast iron pipe from 16 ins. to 36 ins. in diameter, laid in dredged trenches in the bed of the river.

At two points between Paterson and Newark the main sewer passes beneath tidal streams classified by the Federal Government as navigable waters, first, at Yanticaw or Third river and again at Second river, at the northerly boundary of Newark.

Masonry siphons have been constructed beneath both of these streams at such a depth as to give 16 ft. clearance from mean low water to the top of the structures.

The Third river cross consists of twin reinforced masonry conduits, each 6½ ft. in diameter built upon a pile foundation. Inlet and outlet siphon chambers are provided together with a sand-catcher and relief gates. The Second river crossing is similar to that at Third river except that the two 7-ft. conduits are provided for the increased flow at this point.

Flow Divided at Pumping Station

The sewage upon reaching the Newark Bay Pumping Station enters a bellmouth which divides the flow into three channels, each 12 ft. wide. Traversing these channels, the sewage passes through roughing screens for the removal of floating trash and enters the grit chambers. Here the waterway is widened and deepened to such an extent that the reduction of the sewage velocity to nearly 1 ft. a second causes the deposition of the sand which has been carried along with the sewage. Continuing from the grit chamber, the sewage enters the screen house, where double screens are inserted in each of the three sewage channels for removing the papers, miscellaneous refuse and a considerable portion of the larger suspended matter from the sewage. From the screens, the sewage passes into the suction sewer, and then to the pumps, which lift it 40 ft. into the sedimentation basins.

Three vertical centrifugal pumps, each having 60 ins. diameter inlet and discharge ports and 140 ins. diameter impellers, are installed for this purpose. Each pump is directly connected to a triple expansion engine by a 12-in. diameter vertical shaft. The capacity of each pump when turning at a speed of 100 r.p.m. is 100 mgd. A battery of nine 250-h.p. boilers furnishes the steam.

The sedimentation basins, into which the sewage is pumped, are 550 ft. long and 200 ft. wide and permit of 1½ hours' retention of the sewage, during which period the velocity of the sewage in passing through the basins, is reduced to one-half an inch a second. All the suspended solids in the sewage capable of settling out of this period are deposited in the basin hoppers. Sludge accumulating in the hoppers will be drawn off into a 20-in. sludge main and forced by hydraulic and air pressure to the bay front and discharged into a tank ship for ocean disposal.

9,000 Ft. Run Under Newark Bay

A pressure conduit 11 ft. in diameter carries the settled sewage from the basins to the effluent controlling chamber. This structure is built over the Newark Bay tunnel shaft. The entering sewage passes through sluice gates into a 14-in. tunnel shaft and thence downward to a depth of 250 ft. below mean tide level. At this level the tunnel crosses Newark Bay, a distance of 9,000 ft. to the Bayonne shaft. Here the sewage rises 170 ft. to a level 80 ft. below tide waters and continues through a tunnel 12 ft. in diameter and 17,000 ft. long constructed beneath parts of Bayonne, Jersey City and New York Bay, to a point off Robbins Reef. A tunnel shaft constructed at the New York Bay end of the outfall tunnel is surmounted by a terminal chamber containing valves and mechanism for the control of the effluent in either one or both of the outfall pipes leading to the diffusion area.

From this terminal chamber, two pipe lines lead out straight into New York Bay, a distance of 1,500 ft. to the deep water at the main ship channel. Each pipe line is 8 ft. in diameter and consists of heavily reinforced concrete pipes having tapered hub and spigot joints. These pipes were cast in 50 ft. lengths and laid in dredged trenches 50 ft. apart. Where the bottom excavation is hard, these pipes are laid in heavy concrete blocking; otherwise they are placed on a timber pile and cap foundation.

Off the main ship channel, at a point more than 2 miles from the New Jersey shore the outfall pipes reach a depth of 40 ft. below mean low water. Beyond this point discharging nozzles are inserted in the top of the pipes. The pipes are divided into three fingers on each of the two lines, and from these six fingers in all, and covering an area of 3½ acres in the deep waters of New York Bay are

placed 150 nozzles through which the sewage from the Passaic Valley system will finally be diffused into the waters of the Bay.

This description of the project was prepared by Mr. Van Duyne for the March, 1924, number of "The Newarker."

WATER MAIN CLEANING AT NEW ALBANY, INDIANA

By J. O. Endris, Interstate Public Service Co., Superintendent of Water Works, New Albany, Ind.

New Albany, Indiana, is situated on the Ohio River just below the Falls and, on account of its location, has a considerable river frontage. It is bounded on the west by hills, on the south by the Ohio River and on the east and north by open rolling country. The city itself is rather flat. Due to the advantage of being located on the river, the city in its growth has extended in an eastward direction making it long and narrow.

The Water System

In 1875, when the original water plant was erected, advantage was taken of the hills in the western section of the city, which provided a gravity system of water supply. The pumping station is located near the banks of the Ohio River from which the supply is taken. It is pumped from this point to a series of natural sedimentation basins on the hill west of the city, a suburb called Silver Hills.

Our company some few years ago installed a modern filtration plant adjacent to the sedimentation basins which have a daily reserve capacity of approximately 26,000,000 gals. The water is pumped first into the open basins, then through the filtration plant by gravity into the clear well, then by gravity through a series of distribution mains to the city supply.

The natural pressure obtained is from 70 to 80 lbs. One of the greatest problems that confronted our company was the fact that a great percentage of our daily demand is required in the eastern section of the city which is admirably adapted as a manufacturing locality. Being in the opposite end of the city from our plant considerable loss in pressure and volume was experienced through friction in transmission.

Mains Became Obstructed

In 1875 when the plant was first installed filtration was not thought of and the only means of purification was aeration in the reservoirs, and as much natural sedimentation as could be obtained. This, as the city grew and the demand for water increased, became less and less until at certain periods of high turbidity in the Ohio River, water with considerable sediment was delivered into the distribution system. This along with the natural incrustation, which takes place through long usage of water through pipes, increased the friction losses and decreased the delivery to such a point that in cases of unusual demand in various sections of the city and especially in case of fire, the supply became inadequate.

This necessitated our making some investigations, as to whether our demand had increased to such a point that great expenditures would have to be made in additional main feeder lines, or whether it had been brought about to a great extent by the corrosion that had collected in the lines in the 48 years they had been in service.

In making my explanation of these conditions I do not want to leave the impression that the distribution system in the city of New Albany, laid out 1875, had all the necessary provisions made to take care of the present demands on it. We did find out, however, through tests and experiments that the older portion of our distribution system was very badly corroded and that some increased efficiency could be obtained by a series of main cleaning operations.

Main Cleaning Begun in 1922

This work was begun on a large scale in 1922, but only in our smaller distribution mains in the outlying districts of the city where the effects of low pressure were so noticeable.

Owing to our rather high general pressure carried throughout the gravity distribution system of the city, quite a few manufacturers have found is greatly to their advantage to provide themselve with automatic sprinkler systems. A good many were able to obtain decidedly lower insurance rates with one source supply sprinkler system, depending upon the water company to supply this, which was accepted by the insurance companies and the State Inspection Bureaus.

This in some cases placed us in a rather embarrassing position since all manufacturers desiring sprinkler systems connected to our supply felt that they should enjoy the same privilege as others who had obtained approved single source connections from us and insisted that they be furnished the same service in their local-

ity and thereby prevent their having to spend considerable sums of money on the installation and maintenance of a secondary supply.

Of course, we did not feel obligated in all cases to fulfill the manufacturer's wish, as some concerns located their plants in such isolated districts that our distribution mains were unable to take care of the excessive demand. However, the policy of our company has always been to be as fair as possible, commensurate with the returns obtained therefrom.

Incidentally I would like to mention that the requirements of the inspection bureaus and insurance companies, in order to protect themselves against losses are many times not only an injustice but an imposition to the water company furnishing service.

Illustration of Value of Cleaning to Large Consumer

I want to mention one particular case where this year's cleaning operation materially benefited one of our large factory consumers.

The Pickrel Veneer Company was anxious to install a sprinkler system but wanted it on the one source supply. The Inspection Bureau came to New Albany, made their tests and reported back that our supply was insufficient. My company at that time was very doubtful regarding the results to be obtained from main cleaning and I persuaded them to let me try the idea in this particular section.

Today we have a 6-in. sprinkling connection with the Pickrel Veneer Company's plants and one that has been accepted by the Inspection Bureau and the Insurance Company entirely due to the results obtained by main cleaning work.

While the static pressure was not materially changed the volume delivered was increased by about 40 per cent and yet when we proposed to this particular manufacturere that we use this method in furnishing him with adequate service, he would not accept it and stated further that he did not like to see us waste our money in this manner, but we have today in our files a letter from him commending us upon the results we obtained and the benefit we were able to give his plant.

The 1923 Program

The results we obtained in our program for 1922 were so satisfactory that we increased our program for 1923 and undertook what we considered a very hazardous job, in order to increase the service to our consumer.

I previously mentioned the fact that our main distributing arteries from our reservoirs on Silver Hills were a portion of the original plant, and these were badly in need of being brought back to their original capacity.

One of these mains 16-in. in diameter is the nucleus of the eastern supply of the city and taking it out of service would not only cut the pressure more than half, but what is more serious, it would reduce the volume by approximately 60 per cent.

There being three lines, two 12-in., and one 16-in., to be cleaned, we chose the smaller ones first in order to increase their efficiency as much as possible before trying the 16-in., leading to the factory district. In pipes of this size where the pressure is sufficient the cleaning machine is pushed through by the water and as long as there is no obstruction such as valves partly closed, valve stems hanging, lead from a poorly poured joint, or a sharp right angle bend, one may feel sure that the machine will bring the pipe within 98 percent of its original capacity in a very few minutes.

These two 12-in. lines pass under two creeks and through a tunnel approximately 300 ft. long where we realized it would be a very serious matter if the cleaner became obstructed. We were very fortunate, however, to get the cleaner through this portion of the line but when we reached the city and under the first block of brick pavement we encountered our first obstruction.

Pressure Pushes Cleaner

Incidentally, following up a cleaner that is being pushed through by the pressure of the water is very interesting. Under ordinary circumstances it can readily be followed witn an aquaphone placed against the ground just above the point where the pipe line is located. In some cases, however, this method fails and it is necessary to determine the location by opening fire hydrants or various valves along the line to ascertain by the flow of water the approximate location of the cleaner.

At our first obstruction it was necessary for us to tear up the street, break the pipe where we found the cleaner had become caught on lead from a joint that had been poorly yarned before pouring. In fact, when we got it out and weighed it, it was equal to a full pig of lead or 100 lbs. After this, however, it took but a short time to finish the 12-inch sections

as we encountered no more serious trouble.

The first section of 12-in. main cleaned in one shot was 2,200 ft.; the second was 2,700 ft.; and the third was 465 ft., which completed the work on the 12-in. lines into the distribution system of the city. Our next task was to undertake the cleaning of the 16-in. line from the reservoirs to Vincennes and Elm Streets in the eastern section of the city, a distance of a little over two miles.

Cleaning the 16-in. Main

In this length there were two right angle turns. Not knowing whether these turns had been made with 90 degree bends or two 45's, it was necessary for us to determine this so as not to run any chances. In fact it was necessary for us to eliminate all the possibilities of danger that we could anticipate, in order that this line could be taken out of service and placed back again within the shortest possible time.

We had hoped to begin the first thing in the morning and have the line back in service by noon time. Before we began, however, every manufacturing concern affected, and in fact every large water consumer was notified by a personal letter, telling them of our intentions, and what we hoped to accomplish by our work, and suggested that while this work was in progress that particular diligence be given the subject of fires.

A good many of the manufacturers helped us to the extent of stationing a man at their plants during this period, whose duty would be to locate fires in their incipiency, if such should occur. We also asked the help of the Fire Department in realizing fully the deficiency that would occur in the water supply and wherever possible to use chemicals.

Then, we determined if all the valves leading to and from this line were in good operating condition, and found them all satisfactory. We were then prepared to insert the cleaner in the outlet from the basin on Silver Hills ready for its journey through the city.

The next morning our work began and the first trouble we encountered was the breaking of one of the stems in the valves of our 16-in. main at the base of the hill. This delayed our work about a half a day, during which time the pressure in the city had been greatly decreased. With the help of one of the pumping engines of the Fire Department in taking the water from the ditch while repairs were being made, we overcame this trouble.

We were again ready in the afternoon to make the shot and to our surprise and satisfaction the cleaner traveled the entire distance of over 2 miles in about 40 minutes and brought with it tons of refuse from the pipe. In fact aside from that which was washed into the sewer in the surrounding locality, two 5-ton truck loads of reddish-brown substance resembling iron oxide, was removed from the street.

The pipe was examined as soon as the water was pumped out to determine the efficiency of the cleaning, and found to be practically in its original condition; even the tar coating on the pipe was perfect.

All replacements were immediately made and the same evening about five o'clock the valves on the line were opened and observations made on the various test gages that had been placed through the city.

Results from Cleaning

It was gratifying to find that the static pressure in all sections affected by this line was increased from 9 to 10 lbs., and with various flow tests made within the next few days an increase in delivery of from 30 to 45 percent was found. This completed the major portion of our work. In addition we cleaned one half mile of 10-in. and several miles of 6 and 8-in. with equally good results.

We have found by experience that we have so increased the efficiency of the system that outside of some cross connecting mains which we ar installing from year to year, we have been able to postpone a great expenditure on new distribution lines indefinitely.

We have just signed another contract with the main cleaning company for our 1924 cleaning program, in which we expect to clean from 6 to 8 miles more of our mains.

We use our own organization for this work with the exception of a superintendent, who is furnished by the main cleaning company along with the equipment. The average cost to us, including all sizes, has been approximately 22 cts. per foot.

Incidental Advantages of Cleaning

In conclusion, I have found in our experience of main cleaning that we not only accomplish the purpose of increasing the efficiency of the mains but it is also an excellent way of detecting leakage, de-

fective valves, closed or partially closed valves, sizes of lines and where they begin and end, and various interesting conditions on which our records on the older distribution system were vague.

The foregoing paper by Mr. Endris was presented at the recent annual meeting of the Indiana Sanitary and Water Supply Association.

DISCUSSION OF PRINCIPLES UNDERLYING A MODEL TAX SYSTEM

(Editor's Note: The present discussion is from the report of the Committee of the American Association of Engineers on "Public Service and the Tax Rate." The report was written by Mr. T. W. Barrally, chairman of the Committee. Instructions to this Committee were as follows: "This Committee shall study the needs and costs of public improvements and devise methods of increasing efficiency of administration and eliminating public expenditures. It shall further a campaign of public education on the need of planning public works ahead in a consecutive and economical program and of consistent adherence to the program thus developed.")

The large revenues required under present conditions has led the Committee to present in outline the principles upon which a model tax system can be framed for securing such revenues for a system of State and Local Taxation and for a division or allotment of the revenue between the State and local governments. Since nearly one-half of the national wealth is in land and improvements, placed upon land, and further since about 80 per cent of all taxes raised for State and local government is levied as a property tax, the Committee has submitted a plan of assessment for securing the greatest revenue on a fair and scientific basis. This great revenue is levied at the site of the property and the methods now in use are so inefficient and unscientific that the need of introducing the system into all the taxing districts of the country is imperative. In the large cities only where reform in administration has been undertaken and in a few of the smaller cities, is there to be found any proper system of listing property and of making valuations based on anything more than guess work.

Administration

Reform in administration has been of recent development, both in nation, state and city. We have developed a democratic form of government but have failed to devise efficient administration due to a lack of a system of popular control. Reform has proceeded under three ideas of administration. The executive leadership type; the commission type and the legislative standing committee type. While there will be division of opinion on these principles of administration, a budget system is now regarded as a necessary part of any plan of administrative reform. An outline is presented of the features of administrative reform which has been attempted in the past 16 years in this country covering Federal, State and Municipal government and a discussion of the Budget System as a method of popular financial control of expenditures. The Budget System is an annual financial program which has been found to be the only effective means so far devised of securing responsibility in government and should be made a part of every system of reform in administration.

The Need of a Systematic Program of Public Improvements

This subject has been carefully investigated and is set forth in the report. A discussion is presented of a program for Federal, State and Municipal work together with a consideration of a financial plan which should always be made a part of any construction program of planning public works. The rapid spread of the city planning movement indicates that our people are taking a keen interest in the subject.

The Committee recognizes that its duties at present should be confined to the formulation of general principles and not to attempt to establish in detail methods of procedure. All programs so far attempted have been at first local in character requiring local treatment. One of the duties of the Committee is to prepare a plan for an educational campaign of the need for such a planning program and consistent adherence to the programs developed.

The Committee are not yet in a position to submit a definite plan but submit the report of work so far completed with the hope that its publication may bring out an interest in the subject and develop ideas that will assist in preparing a definite plan of education and publicity

Taxation and Revenue

Section 1.—Since governments exist by taxation the problem of revenue is in-

separable from that of taxation. We are all paying taxes to maintain several forms of government—Federal, State, County and City. The sum of these taxes is the total cost of government.

The total expenses of State and local government in the State of New York for 1918 were $436,000,000. Of the total, expenses of State government were 17 per cent, the remaining 83 per cent being the costs of City, Village, County and Town governments. Eighty-three per cent of the costs of municipal government were levied on real estate or property taxation. With the adoption of the income tax by the State, the proportion falling upon property is about 80 per cent. This enormous sum is distributed to their property holdings and the fairness and efficiency of the assessment is a matter of the greatest importance.

The present large revenues required has led to much study and investigation by legislators seeking to devise a system of taxation for securing sufficient revenue with equality, certainty, economy and convenience. Such a system must be derived from several sources to eliminate the defects that always arise from a single source. In 1918 a committee appointed by the National Tax Association to prepare a plan of a Model System of State and Local Taxation, after holding meetings and discussions on the question, prepared a preliminary report. A general agreement was reached on the principles upon which such a system should be based. It is believed that a final form of such a system can be readily reached after mature consideration of details. Five principles upon which any system of State and local taxation may rest are set forth by the committee as follows:

Five Fundamental Principles

Such a system must be capable of yielding the revenue required, it must be practicable from an administration standpoint; it must be adapted to our Federal system of government; reconciling the conflicting claims of several states and avoid double taxation; it must respect Constitutional limitations; it must represent as nearly as possible a consensus of opinion and finally it must not propose measures foreign to American experience and contrary to the ideas of the American people.

Tax laws enacted in our States have in general recognized three fundamental principles quite clearly recognized. The first is that every person having taxing ability should pay some sort of a direct personal tax to the government under which he receives personal benefits; the second principle is that tangible property, by whom owned, should be taxed in the jurisdiction in which it is located; the third principle is that business carried on for a profit in any locality should be taxed for the benefits it receives.

While much difficulty has arisen in the application of these principles it is believed that they have been due to illogical methods and not from any inherent defects in the principles themselves.

The plan which the committee recommends is intended to reconcile conflicting interests of the States and to bring about a full and adequate taxation of income, property and business and secure as much income as the States and local governments can hope to derive from these sources.

Proposed Personal Income Tax

There have been four forms of personal taxation employed which included poll taxes, taxes upon personal fortunes, presumptive incomes such as rents and finally the personal income tax. The three first mentioned present many difficulties and have therefore been abandoned. The personal income tax is levied upon persons with respect to their incomes and is fairer and better fitted to carry out. It is now in force in New York, Massachusetts and Wisconsin and has proved to be a popular tax.

The Proposed Property Tax

This is a tax on tangible property levied exclusively at the place where such property is located. It is recommended that the tax be confined to tangible property and that all intangible property be exempted from taxation as property. All attempts to reach such property has resulted in failure and the personal income tax will reach the property in a fairer way without the risk of double taxation.

The Proposed Business Tax

Many methods have been applied including licenses and ordinary forms of taxation. Much difficulty has arisen in collecting such taxes and the committee recommends that the proposed business tax be levied upon the net income derived from business carried on within the State levying the tax.

Considerable investigation by business experts remains to be carried on before the details can be fully arrived at.

Such a system as is here proposed should satisfy all the claims of the State

and provides a method of taxing all persons fairly and fully at their place of residence for the benefits derived from the government. The combination of taxes provided will give better results than any one tax which will yield the same amount. It will avoid the inequality in the operation of any one tax.

The State can administer the personal income tax and the business tax leaving the local governments as at present to assess and collect the property tax. The amounts collected should be allocated between the State and local governments according to the amounts needed. A great deal of flexibility is possible in this respect and the several States may readily make these adjustments according to their needs.

Property Taxation

One-half of the total wealth of the country consists of real estate. It has already been noted that about 80 per cent of all money levied for State and local government is borne by real estate or property taxes and about 83 per cent of all municipal taxes is derived from property. The need of a thorough-going and scientific method of assessment is obvious. An examination of the assessments rolls of the municipalities reveals a chaotic and inconsistent state of affairs both in respect to methods and administration. This is due to electing and appointing assessors without knowledge of values, or correct methods of assessment. Property is listed without the aid of maps and values are placed on property largely by guess work. The first step in securing an accurate assessment is to have tax maps prepared showing a complete record of all land holdings. Such maps should show the dimensions of parcels and the names of the last owner of record. The lot and block system of indexing and recording property will be found superior to all other metohds; deed books for recording all transfers should be kept in the Department of assessment. The problem of valuation must then be considered and a method devised to equalize the land values and also obtain a correct valuation for all classes of buildings. The preparation of land tax valuation maps recording the unit prices per foot front for lots of standard depth will be found necessary to accomplish the desired results. The listing of all types of buildings was probably first attempted in New York City where factors of value applicable to various types of buildings were adopted. Architects and builders have long been accustomed to using cubic feet and square foot factors in estimating the cost of structures and these are equally valuable in checking values for the purpose of assessment.

The Department of Assessment should also keep a record of all guides to value, such as the consideration given in deeds, and mortgages, the rental values of property, revenue stamps on deeds, and the asking and holding price of property. A record of all building permits issued should be kept as well as all other clues to value. Many cities have installed scientific methods of assessment working independently but finally arriving at substantially the same results.

A Good System of Assessment

A special joint committee on taxation and retrenchment, in a report to the New York State Legislature, after holding hearings in several of the cities of the State, has summarized all the elements involved in the preparation and installation of a good system of assessment based on the results of their investigations. These are set forth as follows:

1. Assessment at 100 per cent of market value.

2. Tax maps showing metes and bounds of all property within the limits of the taxing district.

3. The block and lot system of indexing property holdings and office records.

4. The adoption of the unit foot system for land values.

5. The adoption of an approved depth rule, corner influence rule, alley rule, plottage rule, and such other minor rules as are necessary.

6. The preparation and adoption of a standard building classification with unit factors of building value.

7. The persistent collection of all information bearing on property values and its preservations in permanent form.

8. The installation of calculating machines, wide typewriters, files and modern office equipment.

9. The preparation of a land valuation map covering the entire city.

10. The publication of the tentative assessment where practicable.

Such a system drawn from the experience of the most successful departments in the large cities and which has been adopted gradually in other cities is adapted to all local units, will secure larger revenues, with a moderate tax rate on a basis of fairness and equality. It

will increase the total valuation and ensure a higher credit on which its loans are based.

Economy and Efficiency in Administration

A knowledge of our system of government is essential to an understanding of the causes that have led to a failure in methods of administration. In a democracy efficient government must be secured through popular control. The essentials of popular control over government were stated by Jefferson as follows: (1) popular election; (2) acceptance of the rule of the majority as essential to political justice; (3) arraignment of persons at the head of government for trial on evidence; (4) the right of appeal to the electorate. The first two of these principles have been well worked out in practice and have now become well established but we have failed to develop a responsible leadership.

The struggle between autocracy and democracy, between legislative and executive leadership has resulted in authority being vested in party bosses in the rule of legislative standing committees and in what is often termed "invisible" government. With divided responsibility there has come inefficient administration, a multitude of departments, with overlapping duties and a great waste in the expenditure of public revenues.

About 16 years ago a movement started looking to a reform in administrative organization and a budget program is one of the results of this demand. This movement began in New York City and spread to other cities. Gradually people began to realize that a budget in connection with administrative reform was a means of holding officers to account, a means of showing to the people how much money was needed and how it was to be spent, a means of planning for things needed and of locating responsibility. President Taft took up the movement for a thorough reorganization in the methods of the Federal system of administration. He appointed a commission of "Economy and Efficiency" to report on the whole subject of reorganization of the government departments and in a message to Congress in 1918 recommended the passage of a budget act. While President Taft was unable to secure the passage of his program, nevertheless his advocacy did much to advertise the need of reform and the wide publicity arising out of his efforts caused the movement to spread to the States and municipalities. State Commissions were appointed to report on the need for administrative reform and an effective budget procedure. The State movement followed the inquiry begun by President Taft in the formation of commissions, boards and departments having for their purpose the reorganization of government in the interest of efficiency and economy.

The State of Wisconsin led with its "State Board of Public Affairs" in 1911; New Jersey and Massachusetts followed with similar agencies for reform in 1912. The following year four more States were added to the list until at the present time nearly all of the States have either reorganized or made an attempt in this direction.

Reorganization in Cities

As already stated above the need for better service was first felt in the large cities where population is concentrated. In the great City of New York the demand for reform in methods became acute. When the five boroughs were to be consolidated into what is now the Greater City of New York a new charter was adopted. In this charter control is centered in the Board of Estimate and Apportionment, a body composed mainly of elected executive officers. The central governing body is charged with the duty of making plans and executing them. The method adopted for planning is the charter provision that the Board of Estimate and Apportionment should make a budget. The Board of Aldermen which formerly governed through its standing committees, is retained but stripped of all but the power of review and approval. The mayor is given a seat in the Board of Estimate and Apportionment and in this manner is provided a way for responsible executive leadership. While the principle of executive leadership is introduced, the mayor is not the responsible leader, the leadership being shared with three other executives elected by the city at large.

The City of Rochester, N. Y. has secured one of the best charters so far adopted. It provides for a mayor, a single council and a Board of Estimate and Apportionment. The mayor is the responsible head of the City and thus the principle of administrative reform and budget control of expenditures is secured through a single headed executive.

National Municipal League

This is a civic organization which began a nation-wide propaganda for reform

in administration of municipalities. It has advocated in turn and in the order named the following: The Federal Plan; Commission Plan, and the Commission Manager Plan. As defects appeared, it abandoned the first in favor of the second and finally the second in favor of the third. At the present time the Commission Manager or City Manager Plan is being extensively tried, the largest city to undertake the experiment, being Cleveland, Ohio. If we are to adhere to our principles of democracy we must admit that this plan must defeat itself through lack of popular control. If the Manager Plan is to be a device to keep the leauership of the public service out of politics, then there can be no popular appeal and no popular control.

State Governments

The movement to reorganize State Governments has centered around three types or forms of government, viz: The elected executive type; the Commission type; and the legislative standing committee type. Illinois is an example of the first type, the elected executive. The Wisconsin plan has led to a government of Commissions while New York State is a government of legislative standing committees with Governor Smith still trying to force through the Legislature an executive budget plan. A great improvement has been effected in all the States by the reorganization of the government under a few heads and thus doing away with the numerous departments and commissions which had been created from time to time, and by adopting some form of a budget to secure a control of expenditures. In each of these States the people have been seeking for responsible government but in none has the question of popular control been fully met.

The Budget System

The attempt to make an executive responsible through control of the purse, though of long standing in England has had little trial in this country until recent years. As indicated before there has been a century of struggle between those in favor of popular government and those who have stood for class rule. It is now recognized that there can be no reorganization in administration without a thorough going budget system as part of the program. Having provided for an organization for ministering to the public wants, it is equally necessary to provide an organization and a procedure for popular control and the budget system is the only effective means so far devised for that purpose. The budget is an annual financial program outlining the needs for work to be done and the amounts required to do the work.

Budget Acts have varied in methods of administration on similar lines as those indicated in State and Municipal administrations. The executive budget is considered the most effective inasmuch as it places the responsibility upon a single elected executive head of government and on whom the people may fix the blame for failure to carry out its provisions.

Of the budget systems enacted in the States, those of Massachusetts and Virginia are regarded as among the best. The following description of the Virginia Budget system is taken from an article by Governor Trinkle relating to that system.

The Virginia Budget System

The bill was passed by the Legislature in 1918 and became effective in that year. This law established an executive budget system of an advanced type, making it possible to cast off the old complicated and inefficient method of doing business and to take an advanced position among the progressive states.

The law designates the Governor the chief budget officer and thus makes him the actual business head of the State, as well as the chief executive with wide powers for shaping fiscal policies. All State Departments are required to report their future financial needs compared with past expenditures prior to the first of November preceding the biennial meetings of the General Assembly. For his guidance in framing a comprehensive program for submitting to the Legislature, the Auditor of Public Accounts is required to furnish the Governor full information concerning the States current and expected revenues, treasury balances and special funds. With this information, the Governor is able to plan an intelligent budget to submit to the Legislature. A director of the budget is appointed by the Governor with such assistance as may be required to carry on the work. In this manner the Governor exercises a control over expenditures, creating a budget system with operating control as well as a planning system. The following provisions may be noted: The Governor has the power to veto any particular item of an appropriation bill or may return a bill to which he objects only in part, and thus compel further

consideration of these matters before they become law. Provision is made also for co-operation with House and Senate Committees in charge of appropriations in the consideration of budget estimates in order that they may be fully informed as to all items. The respective provinces of Executive and Legislature are so clearly defined and the method of co-operation so open that the people can have no difficulty in fixing blame if political conditions are invoked to vitiate the proper working of the law.

Each institution, under a monthly reporting system, files with the Director of the Budget a statement of its disbursements, in accordance with the budget classification; also a statement of its appropriations and other revenues showing, cash balances and outstanding liabilities. Comparative cost studies of the institutions are also made including the value of supplies produced and consumed as well as those purchased in the open market. The material collected in this manner serves the purpose of assisting in the preparation of future estimates for budget making.

Whatever the form of government it is clear that the budget system should be a part of its administration machinery as it provides a means of keeping a financial control over all departments and securing a government financially responsible with adequate publicity with reference to the manner of disbursing all public money.

The Need of a Systematic Program of Public Improvements

The failure in adopting proper methods of administration under our form of government has undoubtedly had much to do with the lack of foresight in developing a systematic plan of carrying out public improvements and devising the best methods for financing such improvements. In the few notable instances where a comprehensive plan for cities was adopted there has been no real adherence to its provisions. A notable example is furnished by our National Capitol, the City of Washington, where in recent years a commission was appointed to save the plan from further destruction, to provide for its future growth, and to preserve as much of the original plan as is now possible. Slowly there is growing in the minds of our people the need of some systematic plan for the orderly development of our towns and cities and for the carrying out of all great projects; a definite program in State, County and City.

Such a program is being adopted in several of our large cities and is receiving attention in others. It is applicable in principle to all governments and every effort should be made to secure its adoption.

A Federal Program

The present methods making appropriations by Congress for the improvement of rivers and harbors and other Federal projects has long been the subject of criticism and condemnation. It has resulted in the waste of millions of dollars of public money, spent on projects where no commerce exists or is even expected to develop. This method of waste of appappropriations is familiarly known as the Pork Barrel. This situation should awaken our country to the necessity for a real plan for the development of our inland and coastal waterways. A Federal program of improvements should be made for the selection of sites and the construction of all public buildings and all other national projects. A Federal Planning Board should be organized, composed of experts whose duties should be to study the needs and prepare a national program of work. Such a program with estimated costs and recommendations should be submitted to Congress with the National Budget program of needed expenditures for approval.

The State Program

In the last session of the New York State Legislature, a bill was introduced by the Chairman of the finances and ways and means committee for a systematic building program, so the State is at last to enter into a program of public building construction. The plan is to be submitted to the people this fall for the approval of a bond issue of $70,000,000.00 for construction of adequate buildings in the large cities of the State, for State hospitals and prisons and such other buildings as needed to meet the increasing demands of the State.

The Municipal Program

The need for a constructive program was first recognized in the large centers of population, the great cities where rapid growth and ever increasing needs has brought about a demand for better methods. A wide interest in city planning has lately manifested itself in Europe and in our own country indicating that it is a subject which people are much interested in. This interest has

developed not only in cities but in towns and villages and in clusters of cities in the form of regional planning. There has been some misconception about city planning many believing it to be a civic center, or elaborate scheme of beautifying parts of cities. The true meaning is simply a municipal program of orderly development; a looking ahead into the needs of a city and getting ready for the future in all reasonable lines of growth and development.

Naturally there are many elements entering into a comprehensive city plan but the framework or backbone of such a plan has been grouped around four principal features by Mr. Nelson P. Lewis, an eminent authority. These are stated as follows:

(1) Transportation systems, providing the means for quick movement of people and freight in and out of the city.

(2) The street system, by means of which the business is done and ready access provided for reaching homes and places of business.

(3) The parks and recreation grounds provided for the health and comfort of the people.

(4) The location of public buildings for convenience of access and for making a pleasing appearance upon visitors.

Under the head of the sanitation of cities are grouped all those utilities that are necessary to protect the lives and to promote the health and happiness of the people. These will include the water supply with filtration for all surface supplies, a system of sewage and drainage, as well as garbage and disposal systems. These must all be provided and much attention given to estimates of future growth in order to avoid expensive reconstruction in the future. Many other things will naturally suggest themselves but nearly all the other problems will group themselves around the four principal ones above enumerated.

An interesting example of the adoption of a building program looking far into the future is that adopted by the Town of Tonawanda, N. Y. The Town Council, with the assistance of engineering and architectural counsel, including Mr. George C. Diehl, Engineer for the Planning Committee is carrying on the greatest program of improvements ever attempted by any town board. The foresight involved in this program is apparent when consideration is given to the Niagara Frontier. Surrounded by the cities of Buffalo and Tonawanda both rapidly expanding towards the town, the justification for the adoption of a great plan is obvious. There are to be eight trunk line boulevards with wide pavements and a complete system of sewers and water supply. Provision is made for sewage lift stations and disposal plants and for water filtration. Laws have been enacted requiring all sub-divisions of land to be submitted to the engineer for approval and also ordinances relating to building codes, and restrictions and general supervision of all building have been adopted.

Administration

The details of any such program as outlined must of necessity vary with every locality and the necessary agency or machinery of government must be created to carry it into effect. City planning committees, and other agencies have been created to meet the conditions. These have generally followed movements of civic organization which have been the spur applied to the governing officials. Administrative reform should however be so carried out that a permanent body with power to plan all city programs and execute them is a part of the governing body. In New York City the Board of Estimate and Apportionment is such a body having all the necessary power to make such an annual program and to make a budget. Such an organization with a capable engineering staff and other advisors seems to be the most effective for permanent organization.

Financing a Plan

With a program for planning and executing public improvements there must be also a plan for financing it. Many grave errors have been made in the past with respect to the financial procedure adopted for the purpose of paying for needed improvements. A prevailing idea has been that of leaving all or at least a part of such payment to the coming generations. A sale of State Highway bonds for $100,000,000 for a term of 50 years is an instance of such ill advised and reckless financing. Except for these permanent changes such as improvement in lines and grades, the greater part is spent in road surfaces which are worn out in 10 years. The principle of keeping within income should be followed as far as possible. While volumes might be written on this subject, the following suggestions are offered with respect to bonding:

(1) The bonding term should be limited to the period of usefulness of the improvement.

(2) Serial bonds should be adopted with annual payments of principle and interest.

(3) Bonds should be issued for capital expenditures.

(4) A policy of financing recurring annual capital outlays from current revenues.

The principle of local assessment for local improvements has become well established because there can be no public improvement carried out in which there are not some local benefits. The owners of property in the immediate vicinity are often enriched at the expense of those whose property is entirely beyond the area so affected. The equity of this form of taxation has been well established. This plan will enable a community to put itself more on a cash basis.

Much detailed study will be necessary to apportion the direct and indirect benefits to be derived from a particular improvement. In every case it is necessary to determine what portion of the benefit obtained is strictly local and to what extent it affects the entire district or city. The paving of a residential street will especially benefit the abutting owners while on the other hand the widening of a street to relieve heavy traffic will affect a much larger area.

There is another method, long in use in European cities, by which the expense of carrying out important projects in cities may be met in part, namely by the taking of more land than is needed and selling or leasing the remainder after the improvements are made. This is sometimes referred to as the right of excess condemnation. By the use of it a city takes a share in the values created by the improvements effected.

This principle is employed by railroad companies frequently in taking land. The extent to which shrewd investers take advantage of opportunities to invest in lands affected by great city projects might be illustrated by many examples and it is believed that it will eventually become more the custom in this country to apply the principle for the benefit of the community.

THE SEWAGE PROBLEM OF THE SANITARY DISTRICT OF CHICAGO

By Langdon Pearse, Sanitary Engineer, The Sanitary District of Chicago, 910 S. Michigan Ave., Chicago, Ill.

(Editor's Note: Because of the alleged effect on lake levels, and therefore on navigation, of the withdrawal of water from Lake Michigan for diluting the sewage of the Chicago district, the Chicago sewage problem is one of international interest.)

In the 34 years since its organization, the Sanitary District of Chicago has built the Main Drainage Channel from the Chicago river to Lockport, which reverses the flow of the Chicago river, and also the two Collateral Channels, the North Shore and the Calumet. As a result, the sewage has been removed from the entire lake shore of Cook county, some 34 miles long. The Chicago river has also been widened and straightened and obstructions removed, and new bridges built, so as to make a channel with a minimum width of 200 ft. between dock lines. Further, a power house has been built at Lockport on a fall of 34 ft. to recover the power running to waste, whereby electrical power is generated to light the streets and parks of Chicago, run the sewage pumping stations and treatment works and other municipal utilities. This power is a by-product solely, as the primary object of the main channel was the reversal of the Chicago river and the disposal of the sewage of the Sanitary District by dilution.

Disposal by Dilution

The Charter of the District provides for the dilution of the sewage with a minimum ratio of 3 1/3 cu. ft. per sec. per 1,000 people. On this basis, the capacity of the channel, namely: 10,000 cu. ft. per sec., would care for 3,000,000 people. At the present time, the population is in excess of 3,000,000. Further, owing to the steady growth of Chicago and its suburbs, in amount some 700,000 every ten years, and to the additional load produced by the big packing house industry and the Corn Products Refining Company factory at Argo, an additional load equal to over 1,500,000 people has been placed upon the Main Channel over and above wastes of human origin. As a result, the capacity of the channel for dilution has been exhausted.

Supplemental Methods of Treatment

The Trustees of the Sanitary District

have long recognized the need of supplemental methods of treatment to reduce the load upon the channel. Experimental work was begun in 1909 upon domestic sewage. This was later expanded to cover a comprehensive survey and experiments on the wastes from Packingtown, corn products at Argo and the tannery industry. About 3 years ago the Enabling Act of the Sanitary District was amended by the Legislature, making it mandatory upon the Sanitary District to construct sewage treatment works and put them in operation, beginning with 1925, annually at the rate of 325,000 persons per year, until 60 per cent of the then population was cared for, or approximately 1,800,000 people. However, in later negotiations subsequently conducted with the Chief of Engineers of the U. S. Army, a wider program of treatment was offered which would comprise the treatment of approximately 4,250,000 in 1945, with a program contemplating the expenditure of not less than $25,000,000 in every five-year period. Under the program offered, at least 1,290,000 would be treated in 1928.

A Discordant Feature

In carrying out the program, the Board of Trustees has been worried by one discordant feature, that is, the amount of diversion from the lake. The canal was planned for a diversion of 10,000 second feet. However, at the start a permit was issued to the Sanitary District by the Secretary of War of flow of 4,167 c.f.s., a figure based solely upon the navigable velocities in the Chicago river, then a narrow, crooked stream. Since the opening of the Canal, the Sanitary District has spent upwards of $16,000,000 in widening and straightening the Chicago river and removing the obstructions. Believing that this improvement in aid of navigation warranted an increase in the diversion, demands have been made from time to time to secure an increase in the permit from the Secretary of War, but without success.

However, in order to comply with the requirements of the state law under which the district operates, the flow has been increased, so that at the present time about 8,500 c.f.s. are withdrawn. In 1908 a friendly suit was started to determine the rights of the Secretary of War in connection with the construction of the Calumet-Sag Channel, which suit was later widened into injunction proceedings to determine the legality of the entire diversion. This suit was originally heard by Judge Landis, and upon his resignation from the bench was turned over to Judge Carpenter. Judge Carpenter recently rendered a decision enjoining the district from taking more than 4,167 c.f.s., but the effect and operation of the injunction has been stayed by supersedeas during the pending of the appeal to and until the final decision of the Supreme Court of the United States. Meanwhile, as a solution of the entire controversy, Senator Medill McCormick of Illinois has introduced a Bill in the Senate which creates a 9-ft. waterway in the Illinois river and Mississippi river to Cairo, and further would legalize the diversion of 10,000 c.f.s. from Lake Michigan. The Bill further provides for the control of the level of the great lakes by regulating works at the outlet of Lake Erie and Lake Ontario, which works would be built at the expense of the Sanitary District, and further for the construction of supplemental sewage treatment works, so as to reduce the load in 25 years to one-half the present load of human population upon the main channel. This is equivalent to treating the sewage of 4,250,000 people by 1945.

False Claims About Lake Levels

The agitation against the diversion of 10,000 second feet is largely based upon the false premise that more water is diverted from Lake Michigan than should be permitted to serve the best interests of navigation and of the port cities around the great lakes. The facts indicate that the lake levels are constantly fluctuating in accordance with the laws of nature. Daily and seasonal fluctuations are of far greater moment than any lowering of level ascribable to the Sanitary District diversion.

Reducing the diversion will not cure the difficulties which are claimed to occur. The only correct solution on the lake level problem is the regulation of the outfall to hold back the excess water in the spring until fall. The Sanitary District believes that this can be done for around $2,500,000, and has offered to pay whatever the works will cost.

The sewage treatment program upon which the Sanitary District is now actively engaged is based upon a diversion of 10,000 c.f.s. This will require an expenditure of about $100,000,000. If the diversion is cut to 4,167 c.f.s., an additional expenditure of over $25,000,000 is needed for sewage treatment, and up-

wards of $100,000,000 for water filtration. Thus an additional expenditure of $125,000,000 will be entailed, which will not help the lake level problem materially, whereas the expenditure of only $2,500,000 in regulating works would do a real service and permit the lake levels to be effectively controlled.

Treatment Works

During all the discussion and litigation, the Sanitary District has been steadily engaged upon the problem of sewage treatment. The condition of the Illinois river demanded relief. In the sewage treatment program since 1909, two distinct lines of investigation have been followed—one on domestic sewage, the other on industrial wastes. As the engineering studies developed, the division of the Sanitary District into seven major projects became evident (Table I), together with a number of isolated plants for outlying villages where intercepting sewers would be too expensive at present. Of the projects outlined, Morton Grove, Des Plaines and Calumet have been built and are in operation. The work on the North Side project is actively under way, the first contract having been let on Aug. 9, 1923, for approximately $5,600,000, for a portion of the activated sludge plant, to successfully handle 800,000 people.

Operation of Three Plants

In the operation of the three treatment works, the sewage of over 156,000 people is being actually handled on a working basis. The activated sludge and sprinkling filter plants produce a high grade effluent in which fish can live, which requires no dilution. In addition to the activated sludge process, material is being recovered which is actually taken and used for fertilizer by various agriculturists. This material contains about 5 per cent of nitrogen on a dry basis and from 2 to 4 per cent of phosphate. Growing tests made during the past season indicate that this material is successful with many crops such as beans, corn, sugar beets and gladioli. Park Boards are trying the sludge on lawns.

However, extended tests over many seasons will be required in order to demonstrate the true value of this fertilizer, in comparison with other standard materials. The net result, however, has been an advance in the sludge problem, because heretofore until the activated sludge process was developed the sludge had such a low nitrogen content that it was movable with difficulty and was usually dumped. Experiments are still being conducted on the mechanics of dewatering the sludge to determine the best way of removing the solids. In this work a number of types of filter press have been tried upon which extended data will be available when the time comes to determine the method of handling on a large scale. At present about two tons of dried activated sludge are being produced daily, for all of which there has been a market. The best price obtained was $9.00 per ton f.o.b. cars in bags.

In the control of the plants, a staff of chemists and sanitary engineers are engaged, so that from the mass of data accumulated each new plant can be improved.

To sum up, therefore, at the present time, the Sanitary District of Chicago is working upon two programs: One legislative, the other constructive, with a view to clearing up the whole controversy which has raged for over 20 years. In this program it is hoped to provide for the utilization of the existing capacity in the Channel already built by a diversion of 10,000 c.f.s. The lake level problem will be controlled and solved by the Regulating Works. The condition of the Illinois river will be wonderfully improved by the construction of sewage treatment works on a scale which is practically unpredecented. By this program, it would seem possible to harmonize all the conflicting interests and secure a constructive development which will be helpful, not only to the Illinois river, but to the entire basin of the great lakes.

Many of our citizens have supposed that the Main Drainage Channel solved forever the problem of the treatment of the sewage from the Sanitary District, but the old Main Channel is a machine, and, like any other machine, has a very definite capacity for work. This capacity was exhausted several years ago, necessitating the construction of supplemental works. From the standpoint of the future, regardless of the outcome of the present discussions, so long as Chicago continues to grow, there will be a sewage problem before it, necessitating every ten years the completion of additional facilities larger than are now required for a city of the size of Baltimore or Milwaukee alone. Such is the problem before the Board of Trustees of the Sanitary District and the people of the Sanitary District.

TABLE I.—SEWAGE WORKS OF THE SANITARY DISTRICT OF CHICAGO

Works	Population Served 1922	1930	Date in Service.	Type of Plant.
Morton Grove	1,127		Dec. 9, 1914	Imhoff tanks, covered sprinkling filter and secondary tank.
Des Plaines River	40,000		Aug. 1, 1922	1 in. 1/16 in. x 2 in. screens; grit chamber; activated sludge.
Calumet	150,000	225,000	Sept. 22, 1922	1 in. screen, grit, Imhoff*.
Glenview		868	Under construction	Imhoff tank, sprinkling filter, and secondary tank.
North Side		800,000	Under construction	Activated sludge.
West Side		1,430,000	Future	Activated sludge.
Southwest		1,230,000	Distant future	

The foregoing paper by Mr. Pearse was presented at the 1924 meeting of the Illinois Society of Engineers.

DEBT FOR RURAL HIGHWAYS BUT SMALL PART OF TOTAL BONDED INDEBTEDNESS

(Editor's Note: The information given herewith is from an article by Henry R. Trumbower, Economist, U. S. Bureau of Public Roads, Washington, D. C., in the May, 1924, issue of Public Roads.)

The attention of the public has frequently been called to the amount of outstanding bonds which the States and their several subdivisions have issued from time to time to meet public expenditures. It has been intimated that a very substantial part of this public indebtedness consists of bonds issued to meet the costs of highway construction and improvements. An inquiry made by the United States Bureau of Public Roads into the financial status of our rural highways and the recent reports of the United States Census Bureau relative to State and local taxes and public indebtedness furnish the basis for a determination of the facts. An examination and analysis of these data prepared by governmental agencies show that for the country as a whole *the indebtedness incurred on account of rural highway expenditures accounts for but a small part of the public indebtedness to which the States and their subdivisions have obligated themselves.*

At the end of 1921 the total amount of highway bonds outstanding was $1,222,312,300. Of the whole issue 72 per cent are represented by local bonds, the obligations of counties, townships, and districts; 28 per cent are the obligations of State governments, as shown by the following table:

	Amount	Per cent
State Bonds	$ 345,574,100	28
Local Bonds	876,738,200	72
Total	$1,222,312,300	100

There are only two States in the whole country which have no highway bonds of any kind outstanding, State or local. These are North Dakota and Vermont. All the other States have local bonds outstanding, with the exception of Colorado, which has issued State highway bonds but has no local bonds issued for that purpose.

Over Half the States Have No State Highway Bonds Outstanding

Over half of the States, 27 in number, have no State highway bonds outstanding. These States are:

Alabama
Arizona
Arkansas
Connecticut
Florida
Georgia
Indiana
Iowa
Kansas
Kentucky
Louisiana
Minnesota
Mississippi
Missouri
Montana
Nebraska
New Jersey
North Dakota
Ohio
Oklahoma
South Carolina
Tennessee
Texas
Vermont
Virginia
Washington
Wisconsin

New York has the largest issue outstanding, both State and local, amounting to $121,681,100; California is a close second with $101,258,000.

Comparison of Highway Bonds and Total Indebtedness

The United States Census Bureau has reported the total amount of bonds issued for all purposes by States, counties, and all other subdivisions (including cities, villages, townships, and school districts). For the year 1922, which is the closest information which can be compared with the highway indebtedness, the total indebtedness, less the sinking fund assets set aside to meet such debts, was $8,695,906,000. This total indebtedness, which

may be regarded as the net amount, is divided as follows:

	Amount	Per cent
State	$ 936,414,000	10.5
Counties	1,255,226,000	14.5
All other subdivisions	6,504,266,000	75.0
Total	$8,695,906,000	100.0

It will be observed that by far the major part of this total debt, or 75 per cent, is the obligation of cities, villages, townships, and school and other districts; the State and county share was but 25 per cent.

In order to make a closer comparison with the indebtedness for highway purposes, the debt of the counties and all other subdivisions, amounting to $7,759,492,000, may be called local. The direct comparison follows:

	Total indebtedness	Highway bonds — Amount	Highway bonds — Per cent of total debt
State	$ 936,414,000	$ 345,574,100	37
Local	7,759,492,000	876,738,200	11
Total	$8,695,906,000	$1,222,312,300	14

According to this it is shown that the total highway bonds of the country amounted to 14 per cent of the total indebtedness of the States, counties, and other political subdivisions.

At the end of the fiscal year, June 30, 1923, the debt of the Federal Government was $22,525,773,000. Adding to this amount the State and local indebtedness we get 031,221,679,000 as the total indebtedness of the country. Of this amount $1,222,312,300 was represented by highway bonds, or 3.9 per cent.

SAFE USE OF SEWAGE SLUDGE FOR FERTILIZER

By Abel Wolman, Chief Engineer, Bureau of Sanitary Engineering, Maryland State Department of Health, Baltimore, Md.

Experiments indicate that in a sewage sludge free to undergo normal digestion the typhoid fever bacilli will survive probably less than 10 days. The speed with with the typhoid and dysentery bacilli die depends upon the moisture content and reaction of the soil and upon the nature and abundance of other flora. In a dry or acid soil, either moist or dry, most of the pathogenic bacteria will die within 10 days.

It has not been possible to determine the length of time tuberculosis bacilli will survive in sewage sludge, because of the difficulties encountered in their isolation. They may have a greater viability than the water-borne types. It is doubtful, however, that the tuberculosis bacilli would survive more than the 7 days digestion period established in the investigation.

In concluding an investigation of this subject, I stated that "the laboratory evidence of recent date would appear to indicate that, if sewage sludge is held in a sludge digestion tank for a period of not less than 10 days, its application to the soil for fertilizer purposes might be carried out without detriment to the public health through the possible dissemination of vegetable born disease." A series of regulations were presented to the City of Baltimore, after adoption by the Director of the State Department of Health on May 29, 1923, covering the use of sewage sludge for fertilizing purposes. These regulations are repeated here for purposes of official record.

Baltimore Regulations

1. Only such sludge shall be delivered to farmers as has been undergoing digestion for at least ten days.

The wet sludge shall be carted in vehicles that are watertight.

3. Sludge shall be used on ground only before crops are planted. It shall not be sprinkled over or brought in direct contact with growing vegetables.

4. A permanent record shall be kept by Baltimore City of all persons obtaining wet digested sludge, date, location of farm and quantity of sludge taken.

5. The City reserves the right to discontinue at any time the distribution of wet sludge to any farmer.

6. Any person found violating any of the above regulations shall not be allowed to take wet sludge from the disposal plant or to obtain it in any other manner.

7. During those periods that wet sludge is being removed by farmers the City shall have such inspection of the farms where the sludge is used as to be assured that the above regulations are being enforced. The Sttae Department of Health reserves the right to review and change the above regulations.

8. Every person taking wet sludge

from the disposal plant shall be supplied with a written statement from the City authorities in which shall be incorporated Section 1 to 6 of these regulations.

9. All records of wet digested sludge distributed shall be open at all times to the inspection of the proper authorities.

DESIGN AND CONSTRUCTION OF THE HILL-TO-HILL BRIDGE, BETHLEHEM, PA.

By Frank W. Skinner, Consulting Engineer, 20 Vesey St., New York, N. Y.

The Hill-to-Hill bridge, chiefly of concrete arch construction, serves the 70,000 residents of the city of Bethlehem, Pa. It crosses the Lehigh River, Monocacy Creek, several streets and several lines of railroad tracks, gives access to the principal railroad stations, and provides direct communication between Bethlehem, South Bethlehem and West Bethlehem without ascending and descending steep grades and without dangerous grade crossings.

Funds for it were provided by a bond issue and by generous contributions from the Bethlehem Steel Company, adjacent boroughs and companies, public subscriptions and by subscriptions from four railroad companies. It was built under the direction of the Public Service Commission of Bethlehem, Clarence W. Hudson, Engineer, and Rodgers & Haggerty, Inc., Contractors.

Owing to the irregular topography at the site and to the various directions from which it was desired to admit traffic the bridge is of an unusual shape and appearance with a combination of different features that were studied with the aim to provide an economical and harmonious structure of the greatest efficiency.

General Design

The main portion of the bridge crossing the Lehigh River and the railroad tracks on a tangent, is 2,085 ft. long, 63 ft. wide, over all, and 60 ft. high, with 11 main spans. Two of them over the railroad tracks have 171-ft. steel trusses and the others have reinforced concrete elliptical arches with spans up to 147 ft. All were designed to carry 24-ton motor trucks and two lines of the heaviest mill and city traffic with conservative unit stresses and 50 per cent allowance for impact.

The seven ramps affording entrance to the main structure at both ends and at intermediate points increase the total length to about 6,000 ft. and are made partly with arches and partly with beams and girders supported in one case on steel columns, but generally carried by concrete piers. There are in all 18 reinforced concrete arch spans with clear widths varying from 56 ft. for some of the ramps, to 147 ft.

The steel spans have special type trusses designed to avoid obstructing diagonals in the center panels where one span is intersected by a ramp and made duplicate in both spans for uniformity's sake. The piers have rock foundations and plain tapered shafts surmounted, according to their width, by single or double obelisk-like electric light poles of attractive concrete construction.

The depth of the arch ring at the crowns varies from 15 to 30 ins. and each ring was concreted in from 7 to 10

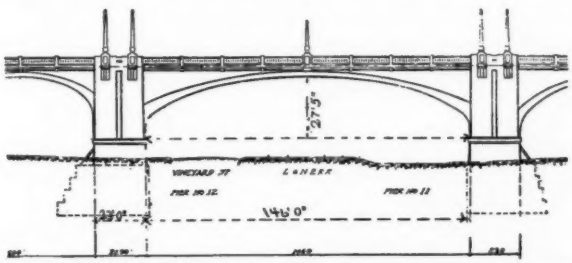
VIEWS ON CONSTRUCTION OF HILL-TO-HILL BRIDGE SHOWING HAYWARD ORANGE PEEL BUCKETS IN OPERATION.

sections for each span and was heavily reinforced close to the intrados and to the extrados with spliced longitudinal rods extending into the pier masonry.

The 107-ft. spans have 65 tons of reinforcement and 690 yds. of concrete, the 146-ft. spans, 175 tons and 1,242 yds., the 65-ft. spans, 45 tons and 418 yds., the 80-ft. spans, 60 tons and 553 yds., 129-ft. spans, 110 tons and 830 yds., and 56-ft. spans, 30 tons and 195 yds. The reinforced concrete girder spans 48 ft. apart. Their combined length is 3,995 ft. Beyond the abutments the roadway is carried on solid earth fills between vertical retaining walls up to 530 ft. in length.

Bids for the contract were opened June 30, 1924, the contract was awarded to Rodgers & Haggerty, New York, and it is expected that the structure, which is now 90 per cent completed, will be ready for service early this summer.

The construction of the bridge required 64,000 yards of excavation, 100,000 yds. of concrete, 34,550 yds. of backfill, 49,400 yds. of arch and ramp fill, 160,000 barrels of Portland cement, 90,000 yds. of broken stone, 60,000 yds. of sand, 1,700 tons of reinforcement steel, 1,650 tons of structural steel, 23,300 sq. ft. of granite pavement, 230,000 sq. ft. of water proofing, 180,000 lin. ft. electric conduit, 133 bronze lamps, 24,000 sq. ft. of steel sheet piles and 2,000,000 lin. ft. of wooden foundation piles.



ELEVATION OF TYPICAL SPAN HILL-TO-HILL BRIDGE.

long and 24 ins. deep are slightly concave on the lower sides to resemble arch soffits. The continuous spandrel walls have vertical exterior and battered interior faces, are reinforced with ½-in. rods and are provided with vertical expansion joints, 25 ft. apart.

There was required for the bridge a total of about 100,000 yds. of concrete made with proportions of 1:2:4 for arch rings, skewbacks, beams, girders, slabs and columns; 1:2½:5 for main piers, abutments, foundations above ground and spandrel walls; 1:3:5 for foundations below ground and one cement to three fine aggregate for exposed surfaces of sidewalks, curbs, gutters, fascia girders and protected steel work. The maximum size of aggregate was 1 in. for arch rings, 2 ins. for plain concrete and ¾-in. for floor slabs, railings and lamp posts. Arches, spandrel walls and some other surfaces were water proofed with about 200,000 sq. ft. of two-ply fabric and tar applied by the Minwax Company.

The main spans have a 44-ft. roadway with two trolley tracks and two 7½ ft. sidewalks with electric light and power ducts underneath. Each ramp has a concrete foundation carried on solid earth fill between the spandrel walls.

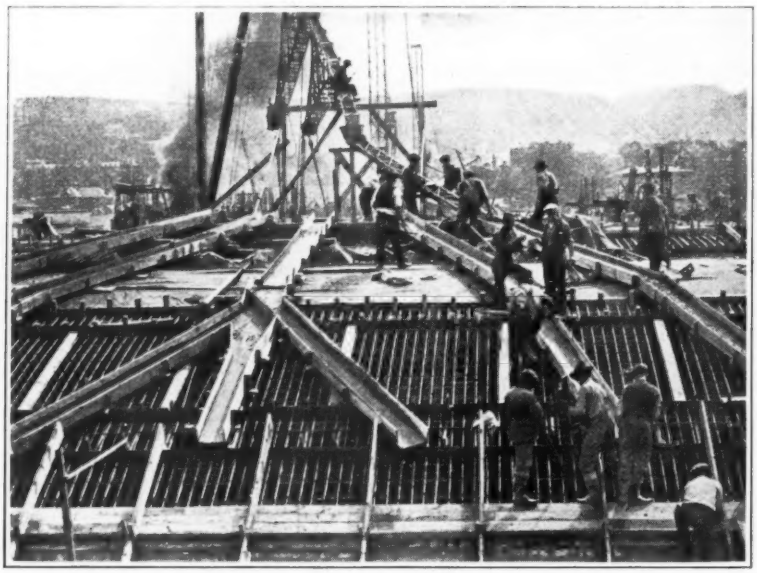
The South Main Street ramp, 511 ft. long and 38 ft. wide in the clear, is carried on plate girder spans of varying length up to about 100 ft. The other ramps have reinforced concrete columns and transverse girders from 15 to 30 ft.

An old highway bridge adjacent to the site of this bridge was removed by the contractor who found that its piers, although resting on timber grillages on the surface of the river bed in water 4 ft. deep, had not been scoured by the 2-mile current and were still in good condition after a service of probably 100 years. New foundations nearby were, however, carried down to rock bearing at a depth of approximately 30 ft.

Pile Foundations

In order to avoid deep open excavation between two tracks of the Lehigh Valley Railroad, the foundation of pier 2 is supported on 100 reinforced concrete piles 32 ft. long driven in a clay and gravel stratum. These piles have cast iron points and were driven by two No. 6, one No. 5 and one No. 7 McKiernan-Terry steam hammers. They weighed 7,000 lbs. and struck about 60 blows per minute on a cushion that endured only two hours steady driving. The piles generally penetrated about 15 ft. in 15 minutes after

which, unless they encountered obstructions, they penetrated at the rate of about 1 ft. in five minutes and were driven to a refusal of 50 blows for the last half inch penetration. When obstacles were encountered a refusal of 100 blows for the last half inch penetration was required. After the driving was completed, a groove, at cut-off elevation, was scored around the pile by a pneumatic hammer that cut to the reinforcement bars, exposing them to action by the oxy-acetylene torches with which they were cut off. Afterwards the top of the pile was easily wedged off, the whole operation requiring two men's work for about three hours.



SPOUTING CONCRETE FOR ARCHES OF MAIN SPAN.

For the river falsework and for the foundations of the steel viaduct, about 750 wooden piles 30 to 35 ft. long were driven by the number 6 and 7 McKiernan-Terry steam hammers suspended on derrick booms. For the river work the derrick was installed on a traveller that first set the pile caps and afterwards erected the falsework bents on them.

Coffer Dams

The excavations for all of the piers except No. 2 were carried down to solid rock through a stratum of gravel saturated with ground water that flowed in great quantities into the deep excavations which were coffer dammed with 14-in. arch web Lackawanna steel sheet piles from 40 to 45 ft. long. The piles were assembled to form complete 35x75-ft. cofferdams and then were successively driven 2 or 3 ft. each at a time by McKiernan-Terry No. 3 and Ingersoll Rand Sheeting hammers, all suspended, without leads, from derrick booms.

The driving was done simultaneously with the excavation and whenever a boulder was encountered was stopped to permit the latter to be removed. The piles were driven at the rate of from 10 to 20 per day. Afterwards the exterior embankment that had been filled in around the cofferdam, was dredged up and placed inside the cofferdam to serve as backfill around the piers. Then the sheet piles were pulled by the McKiernan-Terry hammers driving upwards against steel harness attached to the tops of the piles. They were pulled at the rate of about 20 per day by one hammer which reclaimed them in good condition suitable for repeated driving.

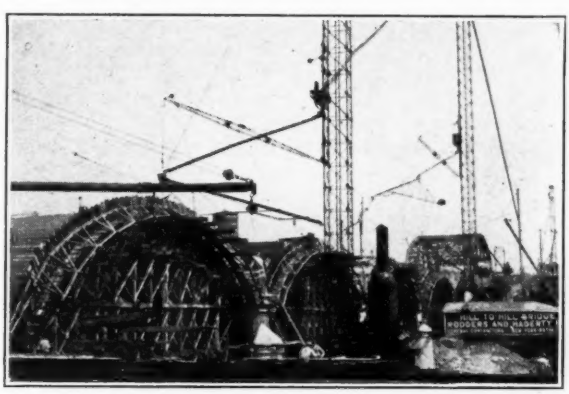
Most of the material from the foundation excavations was handled by 13 stiff-leg and 4 guy derricks with 45 to 80-ft. booms and a Brownhoist Locomotive Crane with 52-ft. boom which commanded all parts of the work. The derricks were equipped with 12 Lidgerwood hoisting engines and 11 Lidgerwood swinging engines operating 6 Hayward orangepeel 1 yd. buckets and 3 Hayward clam shell buckets.

The material excavated from the river

cofferdams was dumped outside them to form protecting embankments, and contained sufficient fine material to seep into the joints and make them practically watertight. Great quantities of water, however, boiled up through the bottoms of the excavations and was removed by a large battery of pumps, some of which were consantly maintained in reserve. These included three Kingsford centrifugal pumps with 8-in. discharge used at piers 7, 3 and 9 and driven by 20 and 30 horsepower motors. Three Lawrence centrifugal pumps, one with 6-in. and two with 5-in. suctions, driven by 20 and 10 horsepower and two Swaby centrifugal pumps driven by 10 horsepower motors. All these pump motors were of the Burke slip ring type operating at 1,200 r.p.m. with 220 volt, 60 cycle, 3-phase current. A 6-in. Gould centrifugal pump at pier 3 was driven by a 50 horse power Westrock. About ¾ of the material was removed by a fleet of 20 five-yard Pierce-Arrow motor trucks hauling an average distance of about ½ mile to the 5-acre spoil bank on Sand Island, where it was stored to a height of about 30-ft.

The excavated material was removed from the spoil bank by an Osgood Steam Shovel that loaded wooden scale pans that were hauled to the bridge by motor truck, and hoisted by traveling derricks moving on top of the finished spandrel walls that swung the scale pans over the arches and dumped in position at the rate of about 250 yds per day. The backfill was wet down with a hose and tamped in 12-in. layers by 10-man gangs at the rate of about 250 yds. per day.

The approach embankments were compacted by an Austin-Western Road Machinery Company's 12-ton Gasoline Road Roller.



FALSEWORK AND FORMS FOR RIVER SPAN ARCHES.

inghouse motor with Westinghouse autotype starter. Two Kingsford pumps with 10-in. suction and 8-in. discharge, driven by 40 horsepower General Electric motors, were also used at piers 3 and 9.

Part of the material was excavated from the foundations by an Osgood 29 steam shovel that loaded about 1,000 cu. yds. of earth at pier 14 into dump trucks. It was afterwards transferred to the stone quarry and loaded 45,000 yds. of stone into 66-ft. end-dump mine cars. Eventually it was transferred to Sand Island and loaded about 45,000 cu. yds. of earth that had been stored there and was carried back to the bridge piers for backfill.

The pier excavations were carried through an average depth of 10 ft. of loam and 10 to 15 ft. of gravel and through a varying depth of disintegrated

Forms and Falsework

The wooden forms for the piers and spandrel walls were made with 2x4-in. and 2x6 in. bevel edge planks and those for the spandrel walls with 1⅞ in. tongue and groove boards with 2x6-in. verticals 16-in. apart on centers and pairs of 3x6-in. wales 3 ft. apart vertically. They were braced by inclined struts and by ⅝ in. permanent horizontal tie rods coupled to short removable end sections that were twisted 180 degs. 12 hours after the form was concreted so as to facilitate their eventual removal. The ends of the lower tie rods were connected by transverse diagonals to anchor bolts in the arch rings to provide for adjusting and maintaining alignment. The fourth tiers of ties from the bottom were anchored by permanent diagonals to resist floating by the bouyancy of the wet concrete.

Small reinforced concrete brackets were built integral with the pier masonry near water level to support the vertical posts in the end bents of falsework for the river spans. These bents and adjacent ones supporting the haunches of the arch and the umbrella tops of the piers were securely anchored by horizontal rods built into the pier shafts and afterwards removed. The falsework at the center of two of the 107-ft. spans was supported on the piers of the old bridge previously in service at this point and on both sides of these piers was supported on pile bents. The other main span falseworks had pile foundations supporting transverse bents of 10x10-in. vertical posts proportioned for 20,000-lb. loads and securely braced by 2x10-in. longitudinal and transverse diagonals and 4x10 in. scabs secured by ¾-in. bolts. In some cases the bents were supported on mud sills carried on 12x30-in. concrete footings and in other cases 15-ft. openings to allow passage through the falsework were spanned by 15-in. I-beams carrying the upper stories of the falsework.

For the main spans the transverse lagging was nailed to 27 lines of longitudinal joists supported on 8x12-in. transverse caps about 6 to 8 ft. apart with wedge adjustments between them and the falsework bents.

Quarry

The broken stone used in concrete was exceptionally uniform, hard and sharp, and was chiefly obtained from a limestone quarry about a mile and a half from the bridge site where the contractor stripped about 3 ft. of earth with a scraper and developed a vertical operating face 60-ft. high and 200-ft. long with a level floor from 40 to 100 ft. wide at the bottom. Six inch holes 15-ft. apart in both directions were drilled the full depth of the quarry face by a Keystone steam drilling machine and charged with 60 and 40 per cent Du Pont dynamite, of which a total of about 51,000 lbs. was used.

The holes were fired in groups of 16, producing about 18,000 tons of rock ready for the crushers. A 29 Osgood and a 40 Marion steam shovel were installed here and loaded the broken rock into 12 end-dump mine cars of 66 cu. ft. capacity that were hauled up a 250-ft. incline by a wire rope operated by a Lidgerwood hoisting engine, and were dumped into the 24x36-in. jaws of a Traylor type A crusher supplemented by a size 3 and a size 6 style D, Allis Chalmers Gates gyratory crushers. The Traylor crusher was driven by a 75-horsepower General Electric slip ring motor and the other crushers were both driven by a 100 horsepower Northwestern Manufacturing Company's motor. The broken stone was handled by a Robbins' belt conveyor and by a bucket elevator and was passed through a 48-in. by 12-ft. Traylor trunnion type revolving scalping screen and through a complete set of Allis Chalmers sizing screens. The scalping screen and conveyor were driven by a 25-horsepower General Electric slip ring motor.

The screenings were sold to a concrete brick manufacturer and the broken stone was delivered in five 5-ton automobile trucks to two 600-ton storage bins at the bridge site. The stone quarry was operated by an average force of 28 men. Sand was delivered by rail and was stored in two 300-ton bins which, like the sand bins, were filled by two ⅝-yd. Hayward clam shell buckets. Cement was hauled 12 miles from the cement company's mill by 5-ton automobile trucks and was stored in two 7,000-bag houses adjacent to the mixer plants.

Mixer Plants

The two main concrete plants were located on the line of the bridge about 1,000 ft. apart so as to command all of the main structure between them and for about 700 ft. radius at each end of it. At each plant there were two 1-yd. Smith mixers with Troy vertical engines, Smith automatic batch meters, water tanks, measuring buckets and charging hoppers. The aggregate and cement were placed in 1-yd. measuring boxes with horizontal marks inside to indicate the amount of broken stone, sand and cement required for the 1:3:5 mix.

When the proportions of the mix were varied corresponding adjustments to the different sections of the measuring boxes were made by nailing inside of them the proper number of wooden boxes, each having 1 cu. ft. volume and thus providing rapid and accurate change of gauge without complication of operations. The batch meters were set for 20 revolutions per minute and the mixer drums were revolved at least two minutes for every batch. The quantity of water used was accurately measured in accordance with the varying instructions of the inspecting engineer.

Adjacent to the mixers were two Insley steel towers, one of them 200 ft. and the other 240 ft. in height which were

connected by a cable from which Insley steel chutes were suspended for spouting the concrete. Between the two towers a 160-ft. auxiliary tower was erected in the river adjacent to the bridge and helped to support the cables.

Concrete was hoisted to the tops of the main towers and spouted to the intermediate tower to a considerable distance from each end of the cable. Counterweighted Insley cantilever trusses were suspended from steel booms installed on each of the towers and carried steel chutes through which the concrete was delivered to any points within their radius.

On some of the ramps and approaches not covered by the spouting system concrete was delivered in buckets hauled on the service tracks alongside or in some cases hauled on trucks and unloaded by derricks into elevated receiving hoppers that were shifted from place to place as required and from which the concrete was spouted a short distance to the forms.

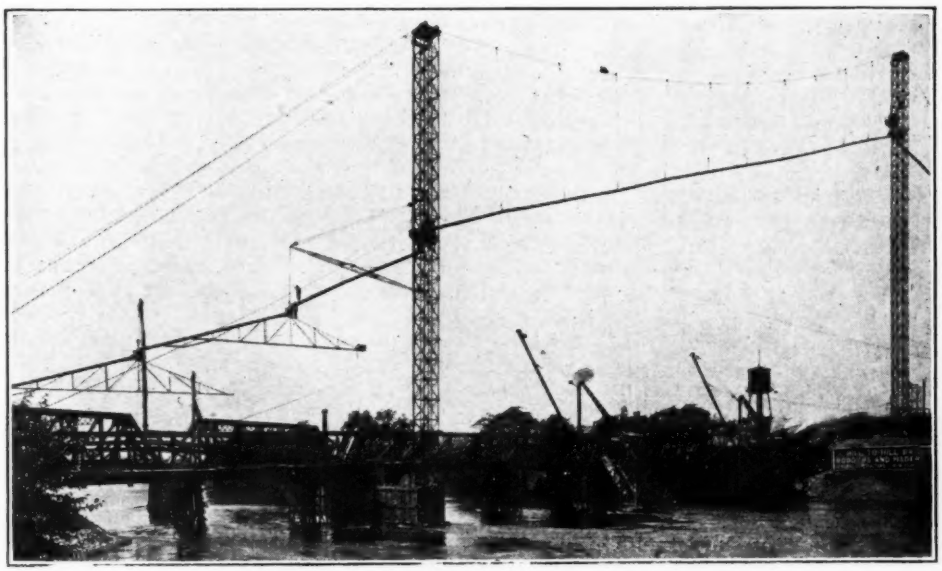
On the south side of the river where portions of the work were inaccessible to the spouting system concrete was hauled by trucks, in bottom dump buckets that were handled to position by derricks serving the forms for the retaining wall in the approaches. The concrete for the foundations here was mixed in a portable machine, thus being handled independently of the main plant. On the north side of the river concrete mixed in the main plant was delivered by an industrial track installed on the top of the two girder spans and was spouted to position in the bridge floor.

The coping was cast in steel forms that were erected and stripped by a small derrick installed on an automobile truck. The railings were cast in about 300 lin. ft. of wooden forms that were used many times over.

Concreting of the foundations was commenced December 14, 1921, and in about one month was discontinued for the winter, resumed March 15, 1922, and continued during favorable weather until the work was virtually completed. All of the concrete for the main piers and arches was spouted from the tower and suspension cable system. The umbrella tops of the piers were cast integral with their shafts forming at their skew back ends construction joints with the arch rings.

The thicknesses of the arch rings at the lower ends were so great that there was abundance of space in the forms for men to enter and properly work the wet concrete around the large number of reinforcement bars assembled there. The largest umbrella top contained about 550 yds. of concrete which was poured in a continuous 24-hour operation.

The largest continuous concrete operation was the placing of 944 yds., spouted into position in 36 hours; the largest quantity placed continuously in one form



HOISTING, SPOUTING AND RELAY SYSTEM OF DELIVERING CONCRETE TO MAIN SPANS.

by buckets was 958 yds. in 24 hours; the maximum amount of concrete placed in one month was 8,723 yds.

The maximum force employed was more than 400 men and in June, 1923, included 15 executives, 10 office men, 13 engineers and assistant engineers, 4 draftsmen, 12 store yard men, 15 mechanical tower men, 84 carpenters, 60 carpenter's laborers, 60 concrete men, 20 concrete laborers, 28 quarry men, 17 chauffeurs and garage men and 60 miscellaneous employes. Construction work was in charge of Walter Caccia, Resident Engineer for the contractor, Rogers & Haggerty, Inc.

PLEA FOR UNIFORM CONSTRUCTION CONTRACTS

By R. C. Marshall, Jr., General Manager, Associated General Contractors, Washington, D. C.

The attention of Congress was called about two years ago to the fact that some fifty or sixty governmental bureaus handling construction work were using about fifty-seven different varieties of contracts in executing their projects, and were doing so, much to the disadvantage of the government. At first this great variety of legal instruments was regarded as merely a harmless display of individualism among officials, or even perhaps a commendable effort to promote the welfare of each bureau, but upon closer investigation, it was found to have created a serious problem in the conduct of federal construction.

Had the different contracting practices established throughout these many bureaus been due entirely to the contract forms in use, correction of the situation might have been comparatively simple, but it was found that many laws governing construction in one or another department had found their way into the Federal Statutes, until the governing regulations were a conglomeration of special conditions.

Lack of Uniformity in Contracts Increases Costs

Consequently construction companies could not know the administrative practices of every bureau or conduct their business to serve economically the special requirements of so many agencies. Many contingencies, not common to commercial work, were introduced into government construction and the inevitable result was higher construction cost. The construction company possibly could not lay its finger on the exact items of additional expense, but it knew from costly experience that a federal job, bid at commercial prices for the same sort of work, was likely to prove a losing proposition.

When the regulations and administration governing construction vary among different agencies, it is inevitable that some of these agencies hold forth greater inducements to commercial organizations than those offered by some others. Under such circumstances it was to be expected, therefore, that certain bureaus and departments of the government received keener competition for their projects than others, and that prices for similar types of construction were also inclined to vary.

Incident to this condition, government officials found that certain bureaus dealt with a number of construction companies who submitted proposals for practically any project to be constructed, but that these companies apparently would not bid on work under another bureau where they did not know the practice.

When it was found that many well-known construction companies had withdrawn from government work and did not desire to submit proposals, it dawned upon the federal authorities that something might be wrong with the system. Therefore, an inquiry was sent to a great number of construction companies and needless to say these companies advised the authorities then that their suspicions were correct.

The business principles governing the conducts of construction work were found to have created a situation analogous to that which would exist if each division in any army were governed by a separate set of army regulations. Some two or three hundred laws and departmental rulings made it practically impossible for a construction company to anticipate, when dealing with the government, just what it might expect in administration of the work, and the contingencies thus created were incompatible with the business policies of many concerns.

Standardizing Government Contracts

As a result of the conditions here mentioned, a special agency was created under the Bureau of the Budget, known as the Interdepartmental Board of Contracts and Adjustments, which is now working on the standardization of government contracts, and seeking to eliminate unnecessary special regulations. This Board

has stated its intention to bring governmental contracting practice as closely in line with commercial practice as existing law will permit and tnen to recommend revisions and codification of federal contract statutes. Through such procedure which is regarded as essentially in the interest of the government, it is proposed to adopt uniform regulations that will enable the government to compete favorably with private and quasi-public institutions.

For two years the Interdepartmental Board has worked steadily toward its stated objectives. After receiving comment from practically the entire commercial world it has developed a standard construction contract, which is to replace the many forms now in use. This document which is practically completed, represents a great stride in commercial equity and will undoubtedly bring back into government work many companies who have left this field, because of its entangling alliances.

While the standard contract represents a noteworthy accomplishment, a more gigantic task is being carried out by the Board in its formulation of a body of contract laws. For a year and a half it has been studying existing statutes and drafting substitutions for many that have long ago served their useful purpose. The work is nearing completion and possibly during the present year may be in shape for transmittal to Congress.

Whether the Interdepartmental Board can induce some of the lawmakers on Capitol Hill to center their attention on the value of this work to the exclusion of individual interest remains yet to be seen, but the opportunity will probably come for every citizen, interested in the construction industry and in the welfare of federal public work to stand behind this Board and help guide its recommendations through much political fog.

When the new government contract has been placed in use, those commercial organizations dealing with a federal agency, will doubtless find that many practices long-branded as ethically and economically unsound, have gone to the scrap heap. In their place will be found, if the intention of the Interdepartmental Board is carried out, a revised code of practice compatible with the established principles of business.

Recognizing Business Principles

Many public officials as well as contractors have begun to realize that the interest of the buyer, as the interest of the seller, is best served when their mutual obligations are in line with sound economics, and unencumbered by queer stipulations impossible of fulfillment. Probably in no other field has there been such utter disregard, or possibly ignorance, of economic laws as in the field of contracting and yet no other industry is so completely dominated by these laws or as sensitive to their action. Such a condition is inevitable in any industry that co-ordinates the products from numerous others.

It is therefore especially desirable that contracts governing construction should be made compatible with the great body of recognized business principles, commonly designated as accepted commercial practice. When this has been accomplished the country will then have a code of contracting, much less beset with lawsuits than at present and much more formidable to the party acting in bad faith who seeks a recovery through some legal technicality.

Unless it is desired to deny the established order of business and take issue with the best business code that human minds have been able to devise, construction contracts like those of other industries should be an expression of this code. Failure to recognize this fact on the part of one or another element constituting the industry is undoubtedly the basic cause of much public criticism.

State Highway Contracts

In one spot or another, the hundreds of individually drawn construction contracts have been out of line with sound commercial practice and the result has been to place a premium on gambling rather than upon efficient construction service. Such a condition was found by the Interdepartmental Board to prevail with respect to government contracts and a like situation appears to exist in the 48 states engaged in highway construction.

This condition is by no means the fault of state highway engineers, but is rather a heritage left them by more or less well meaning politicians, aided and abetted by the legal mind. Neither of these has been accused of long range vision in matters of sound economics, but they have blindly sought to gain the utmost for an individual interest without actually reckoning the cost. Therefore, the State Highway Departments are faced with the same problem that faced the Interdepartmental Board; namely, to find a means whereby

they can protect the interest of the state without smashing the accepted rules of business and losing the benefit of intelligent competition. Competition of one sort they have had in abundance, but ignorant competition by inexperienced concerns has about demonstrated its uselessness to those who buy as well as to those who sell; and it is probable that no one will bear more ready testimony to this fact than the highway engineer.

Protective Clauses

As one reads through the various contract forms used for highways and other public works construction, it is almost possible to trace certain provisions back to certain legal decisions against the state which prompted the inclusion of these provisions. Often some special condition has arisen which was not contemplated by the contract and probably could not have been foreseen and which, therefore, resulted in a claim for compensation. As public agencies naturally do not desire to pay such extras they have frequently tried to spike all claims through the use of some special provision. In this manner public contracts have been cluttered up with innumerable provisions ordinarily unnecessary, but which inevitably add to the cost of construction as well as to the hazard involved.

Stern protective clauses in the public contracts are undoubtedly necessary, but before such clauses are incorporated cognizance should be taken of one very important point, namely, that once these clauses are included there, action generally becomes not optional with the public official, but mandatory. Under such circumstances, he finds himself often obliged to carry out the letter of the contract in a manner that he knows to be inequitable, but which he is duty bound to follow.

Drastic protective clauses of this nature are frequently found in railroad construction contracts, but the freedom exercised by the railroad engineer in making adjustment and administering the work in accordance with his judgment has rendered them inactive. However, in a public contract where such clauses are usually mandatory they are bound to increase the cost of doing business.

Relation Between Costs and Contract Provisions

Within recent years, some cognizance has been taken of the fact that construction costs are inseparably linked with the form of contract government execution of the work; this is due in great part to the two distinctive functions rendered by construction companies, namely, that actually executing the projects and that of insuring the owner against many contingencies which no construction company can control. It may be that this dual function of the contractor is an advisable combination, but viewing it merely from the angle of construction costs, it constitutes an expensive procedure. If some pioneer engineer were to separate these contingencies in his mind from the actual cost, let the state assume those most remote as a possible occurrence, then call for bids for the actual construction work and another bid for assuming the contingencies, he would probably find that the cost of constructing highways as well as the prices bid, had materially declined.

This phase of contract proposition, however, is somewhat aside from the matter of uniform documents. The intention of this discussion is not to touch upon these points wherein practically all highway contracts could well be modified, but rather to treat of the irregularities and differences that constitute a derogatory influence. By this is meant the use of a particular stipulation in one state and not in another which makes construction work in one of them less attractive to a responsible company.

Quantities

An illustration of this point is afforded by a certain provision now used in a number of states, but which has been discarded in others. It states that the quantities upon which the contractor is to bid are only approximate and for the purpose of comparing proposals, and that the state reserves the right to increase or decrease the quantities as it sees fit or to omit any of them altogether.

As each unit of work must carry its proportional share of overhead, the omission of any of these items means that whatever overhead was distributed to such items in the estimate will stand as direct loss to the construction company. In other words, the bidder is required not only to guarantee the accuracy of the department's estimate, but is also required to gamble on whether the department will change its mind and eliminate a portion of the work.

In some states it has been recognized that this sort of stipulation necessitates a contingency allowance or that protection must be sought otherwise in the so-

called unbalanced bid. Consequently they have limited the amount that the work can be changed without a correction of unit price.

Assuming for the sake of illustration that the state of Illinois has the unqualified provision mentioned and that the state of Indiana guarantees the acuracy of estimates and guarantees that it will perform the work shown in the proposal. The Indiana contract will then eliminate the contingent charge and the construction company has to contend merely with the physical problems of the work so far as this particular provision is concerned. The obvious tendency would be for contractors to seek work in those states where they were obliged to do the least amount of gambling.

Bad Contract Provisions Keep Costs High

There are probably twenty other common highway provisions, which react in the manner here cited, against the deflation of construction costs. Some states separate maintenance from construction and accept the work by sections when completed. This practice, like reduction of retained percentage to a safe minimum, cuts down interest charges and also reduces the actual working force required. Some states make adjustments for delays which their own actions occasion wiping out another intangible expense. Materials delivered are paid for in a considerable number of states, thus encouraging accumulation of stocks and continuous operation. To these points may be added numerous others which have been under discussion by engineers and contractors for the past three years.

An important step toward unifying practice in these matters was taken at Kansas City about a year ago when a committee of the American Association of State Highway Officials and one of the Associated General Contractors after investigating the economics involved made joint recommendations upon some twenty-five or thirty points relating to contracting practices. From the engineer's point of view adoption of these principles would benefit the state, not only by solving certain difficulties of administration, but also by effecting a reduction of cost. In the report issued by the Joint Committee, every principle is accompanied by a statement of the reason for its approval which in every case is one of economics. Though this declaration of principles represents but a step towards standardization so far, it could through universal application produce considerable uniformity in highway contracts.

If state highway contracts could be formulated in every state from provisions that have been subject to the test of sound economics as well as the test of law, it would undoubtedly encourage efficiency and increase the longevity of those companies engaged in construction. The death rates of these companies are in no small measure due to the different governing principles encountered when they attempt to carry on work in a state with which they are unfamiliar, and a new flock of road builders every season does not reduce the cost of roads.

At the present time, construction companies building highways are, in effect, engaged in interstate commerce. Numerous variations in the rules of business which they encounter in the different states create a doubt as to the actual requirements of the different localities and retards the progress of accurate estimating and accounting. Many engineering contracts and possibly highway contracts contain provisions contrary to the common law and which will not stand before a court. These clauses encourage irresponsible companies to create dissention and attempt a legal battle that may be won on a technicality. It would seem in the interest of a state for highway engineers to cast out any uneconomic requirements of specification and to establish uniform contractual relations. Contractors could then operate freely in new territory, without running amuck with unusual local requirements as now commonly occurs.

To accomplish this, might necessitate changes of contract provisions which in certain states appear necessary for adequate protection. If this be the case, the problem is then to find a means whereby responsible companies can deal with the departments as they deal with other industries, so long as their obligations are executed in good faith.

Protecting the Public Against Bad Faith

It will necessitate providing a means whereby the department may protect itself against bad faith in a manner swift and sure. In other words an effort should be made through the administration and through the contract forms to make this highway industry an attractive field for the right sort of operators and to eliminate swiftly and surely the man who attempts to dodge his obligations. This can be brought about to a great extent

by uniform contracting principles, which most certainly will constitute a public service.

There is another side to this question, however, which is probably as important as the factor of economics. Uniform contracts would tend to establish customs and precedents in contractual relations that would serve in much the same capacity as a body of common law. They would constitute a practical code which would become generally known to contractors, professional men and to some extent by the public and would enable all parties more clearly to understand the obligations they must perform and a performance that they have a right to expect.

In so far as highway construction is concerned, there appears no sound reason for continuing a multitude of different obligations covering the same type of work—except, of course, where existing statutes interfere. In fact, there is no useful purpose served by the multiplicity of state construction laws. Many of these statutes, like regulations in the government bureaus, having long since served their usefulness, could profitably be revised or repealed.

Formulating a Construction Code

It is unfortunate that the construction world has not long ago formulated its code of contracting practices, but at the same time it is fortunate that nine large national associations of engineers, architects and contractors, operating through the Joint Conference on Standard Construction Contracts at Washington, have practically reached an agreement on such a code. For over two years this body has been working on the subject and within the present year is expected to give the results of its labors to the public.

Even before the Joint Conference had reached agreement on all major points involved it furnished valuable assistance to the government in enunciating sound principles. The mature thought of this conference, could also with active support from highway departments, formulate sound contracting practice for highways and other public construction. The American Association of State Highway Officials has been participating in the conference and throughout the sessions its representatives have given the benefit of their judgment from the viewpoint of highway officials.

No attempt has yet been made to formulate a contract for public works, but if highway officials will undertake this task either through the joint conference at Washington or their own association, they will pave the way for an important public service.

The foregoing address by Mr. Marshall was presented at the 1924 meeting of the American Road Builders Association.

ACTIVITY IN MUNICIPAL BOND MARKET

April is generally an active month in the municipal bond market, since it is the season of the year when work on public improvement programs gets under way throughout the country and bond issues voted to finance public work must be marketed.

This year, reports The Daily Bond Buyer, of New York, the April issuance of state, county and municipal bonds reached a total of $121,295,680, which is the largest monthly output of such bonds recorded so far this year and exceeds the total for the corresponding month of 1923 by $32,000,000.

Due to fundamental conditions in the money and securities markets, there has been a steady demand for these new security issues with prices slightly advanced over the level of the earlier months of the year.

The following table, compiled by The Daily Bond Buyer, of New York, shows the sales of state and municipal bonds in April and the four months ended April 30 for ten years:

	April	Four mos. end. Apr. 30
1924	$121,295,680	$410,524,739
1923	89,030,844	342,666,184
1922	147,300,292	439,984,493
1921	94,052,250	305,595,412
1920	63,102,486	259,768,086
1919	64,358,953	167,324,176
1918	13,962,459	81,967,731
1917	62,454,686	162,112,754
1916	87,590,745	208,040,243
1915	27 096,703	166,304,201

OHIO ADOPTS NEW BRICK HIGHWAY STANDARDS

After a thorough investigation of various types of construction used in the laying of vitrified brick pavements, Mr. A. Stellhorn, chief engineer of the Bureau of Construction of the Ohio Department of Highways and Public Works has issued an order to all district state engineers and other officials to the effect that in the future it will be the policy of the state highway department to use 3-in.

vertical fibre lugless brick on all standard construction.

Following is Mr. Stellhorn's order in part:

"It has been decided that in the future it will be the policy of the State Highway Department of Ohio to use 3-in. vertical fibre lugless brick on all standard construction, and unless the traffic is extremely heavy or other conditions out of the ordinary, No. 3½ or 4-in. brick will be used.

"The investigations carried on by the State Highway Department indicate that if the foundation is ample a 3-in. brick properly laid and filled will carry all modern traffic wihch a highway can be subjected to within the limits of the load laws.

"It might be well to add that in the construction of 3-in. brick pavements extreme care should be taken to properly fill the joints. The statement applies not only to squeegeeing operations but also to the heating of the asphalt.

"You will realize that in changing our standards it is extremely important that the workmanship be absolutely first class so that if any defects are noted they can be charged against that portion of the construction which should bear them and can not be charged against defective workmanship."

THE COEFFICIENT OF RUN-OFF IN STORM SEWER DESIGN

By Le Roy K. Sherman, President Randolph-Perkins Co., Consulting Engineers, 1210 First National Bank Bldg., Chicago, Ill.

The object of this article is to describe a procedure for determining the percentage "C" of rainfall run-off for sewered areas by the rational method whereby Q=CIA, "Q" being the run-off from the area in cubic feet per second, "A", the area in question in acres, and "I", the average intensity of rainfall, in inches per hour, for the time of concentration "T" for particular area in question.

The percentage of run-off, or coefficient "C", is obtained from observed experimental data. It is common practice among engineers when designing for storm sewer capacity, to review the somewhat meager available data and from this, either directly or by analogy, adopt a coefficient "C" derived from a similar drainage area.

It is the writer's experience, that a more reliable figure for the coefficient of run-off "C" can be secured by a separate analysis of the available data on run-off from the pervious and impervious surfaces. This separate analysis of run-offs was used by W. W. Horner of St. Louis, in 1910, but since that time several investigations have been made so that

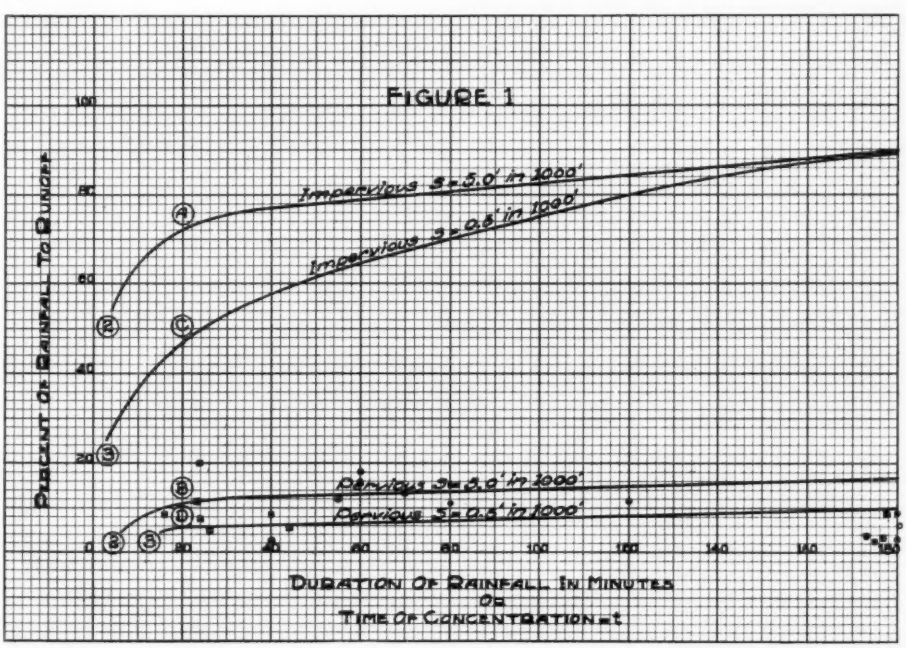


FIGURE 1.

the separate analysis can be applied more definitely.

Review of Conclusions Relative to "C"

Before describing the derivation of the run-off coefficient "C" by the separate analysis, let us review some of the conclusions relating to "C" which have been acquired through the above mentioned investigations.

(1) The percentage of run-off, or coefficient "C" varies with the percentage of impervious surface, the character and condition of the soil, the amount of vegetation, and the time of concentration as affected by the surface slopes and size and shape of the drainage area.

(2) "Variation in surface slopes are of much less importance as affecting run-off than are variations in vegetable cover and character and condition of soil." The average annual run-off from small plots of ground were:

Run-off from sod, 3.2% of rainfall.

Run-off from bare soil, 22.2% of rainfall.

(3) "Rate of percolation, where surface soil is saturated, increases as the rate of rainfall increases, the variation being according to a straight line equation, and the rate of increase being proportionately greater for loose, loamy soils than for heavy clay soils," as shown by the following sprinkling experiments:

Loose, bare soil, saturated, intermittent sprinkling:

1 in. per hr. rain=½ in. per hr. run-off

3 in. per hr. rain=1.7 in. per hr. run-off

Packed, bare soil, saturated, continuous sprinkling.

1 in. per hr. rain=¾ in. per hr. run-off

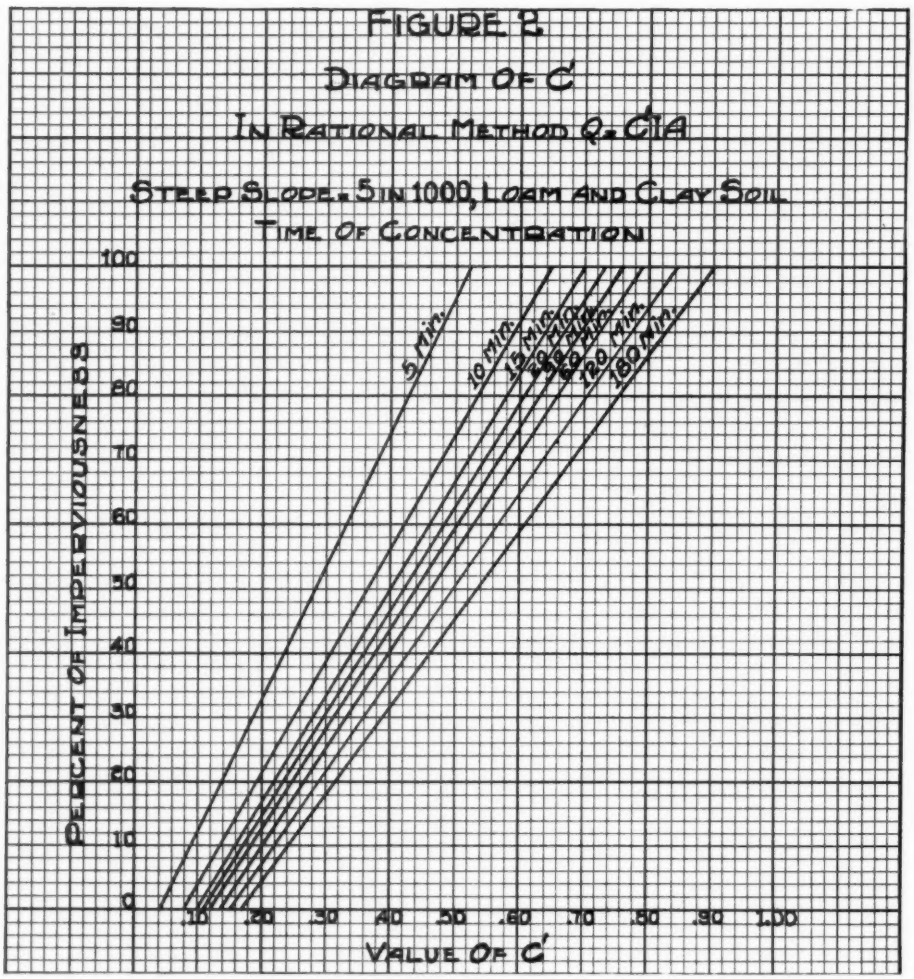


FIGURE 2.

3 in. per hr. rain =2.7 in. per hr. run-off
Same, not saturated:
3 in. per hr. rain=2 to 2½ in. run-off."
(Miami Conservancy District, Technical Reports, Part Eight, 1921).

(4) "The change in percentage of run-off is quite marked during the first 30 to 60 minutes and is comparatively slight thereafter."

(W. W. Horner, Municipal and County Engineering, Nov. 1922).

This applies to impervious surfaces and to hard, bare soils or saturated ground. For pervious soils, the coefficient of run-off appears to be almost constant after the first 20 to 30 minutes.

(5) The coefficient of run-off for any drainage area is made up of the sum of the weighted coefficients of the pervious and the impervious portions of the drainage area:

Let c=Coefficient of run-off for the impervious portion.

Let c′=Coefficient of run-off for the pervious portion.

Let C=Coefficient of run-off for the whole drainage area.

Then C=c × percentage of impervious portion + c′ × (100-percentage of impervious portion.) For example:

C=0.54
c′=0.165
Impervious portion=15% of drain. area
Then C=0.22

0.54 ×0.15=0.08
0.165×0.85=0.14
———
C=0.22

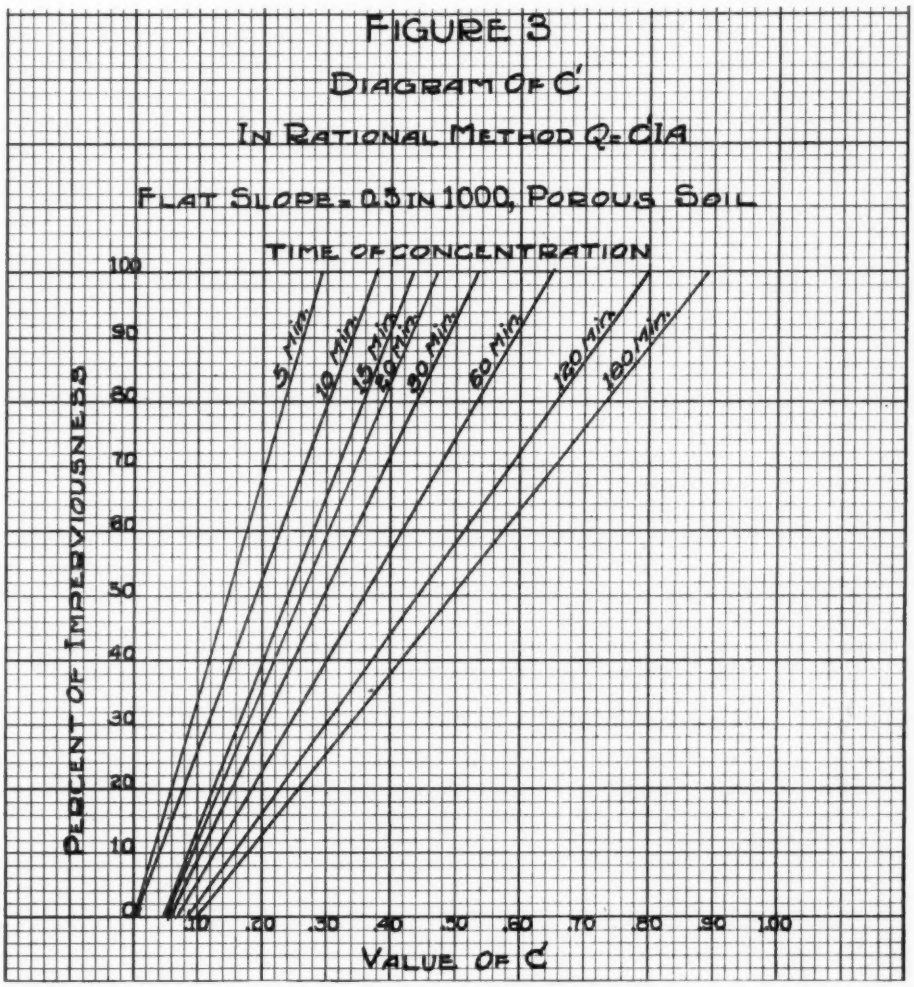


FIGURE 3.

The value of c, the coefficient of run-off from the impervious portion, varies only with the time of concentration and the surface slope and is not affected by character of soil.

Therefore, a proportionate value of c can be readily determined. The foregoing relationship offers a way for computing c′, the coefficient of run-off from the pervious portion, when the data gives C, the coefficient of run-off from the entire, unsegregated drainage area.

(6) The product "CI" decreases with the time of concentration. This condition limits the rate of increase of "C" and furnishes a check on suggested values of "C".

Fig. 1 is a diagram showing the variation of coefficients of run-off with increase of time of concentration or duration of rainfall. Curve A is for impervious area with an average surface slope of 0.5%. Curve B is for pervious, or unimproved area, with the same surface slope of 0.5%. The particular area is at Hinsdale, Illinois, which has a loam and loose clay soil, well covered with vegetation. Curves C and D are for Terre Haute, Indiana, with an average flat surface slope of 0.05%, and a very porous gravel sub-soil. The upper curves A and C, for 100% impervious surface, are derived by analogy from the data of W. W. Horner, (Municipal and County Engineering, November, 1922) on hard, bare ground. The lower curves B and D, for unimproved or pervious surface, are derived, by the procedure given in the foregoing paragraph 4, from data listed on observed coefficients or run-off in "Design of Sewers," by Metcalf and Eddy, and other data by J. W. Schlick in Proceedings of Iowa Engineering Society, 1923, and by the writer at Terre Haute, Indiana, in 1923.

From the curves in Fig. 1, we can tabulate the combined coefficients of run-off for any percentage of impervious area. Such tabulations are as shown below.

These tablulations are shown in diagram form in Figs. 2 and 3.

For comparison, coefficients derived from the diagrams are tabulated with the observed coefficients. (See p. 301.)

The data is arranged in the order of percentage of impervious surface which is the largest single controlling factor.

I consider that the run-off coefficient diagrams, Figs. 2 and 3, when applied with experienced judgment, furnish a useful guide, in the absence of more specific data, for determining run-off. These diagrams are more reliable for drainage areas where the percentage of imperviousness is less than 50%, and for localities included in Myers' group 3, with storm intensities included within a five year maximum frequency.

No attempt is made in this article to produce a new formula for run-off or to standardize conclusions. From the very nature of the problem of storm water sewer design, this is impracticable. The run-off coefficient, in any single drainage area, varies greatly. It may range from a normal of 0.20 up to 0.80 under abnormal and infrequent conditions when very heavy storms fall upon a super-saturated or ice-coated soil. Many districts do not warrant the expense of sewer sizes sufficient to carry these extreme storm peaks.

CASE 2. CURVES A AND B. AVERAGE SLOPE 0.5 PER CENT. SOIL, LOAM AND LIGHT CLAY.

Duration	% Run-off from Imp. Surface	% Run-off from perv. Surface	P—Per Cent of Imp. Area 0	5	10	15	25	35	50	75	100
5 min.	30	0	.00	.02	.03	.05	.07	.11	.15	.23	.30
10	38	0	.00	.02	.04	.06	.10	.13	.19	.29	.38
15	43	5	.05	.07	.09	.11	.14	.18	.24	.33	.43
20	47	6	.06	.08	.10	.12	.16	.20	.27	.37	.47
30	54	6	.06	.08	.11	.13	.18	.23	.30	.42	.54
50	62	6	.06	.09	.12	.15	.20	.26	.34	.48	.62
60	65	7	.07	.10	.13	.16	.22	.27	.36	.51	.65
120	80	9	.09	.13	.16	.20	.27	.34	.45	.63	.80
180	90	10	.10	.14	.18	.22	.30	.38	.50	.70	.90

CASE 3. CURVE C AND D, FLAT SLOPE .05 PER CENT, LOOSE SOIL AND GRAVEL.

Duration	% Run-off from Imp. Surface	% Run-off from perv. Surface	P—Per Cent of Imp. Area 0	5	10	15	25	35	50	75	100
5 min.	57	4	.04	.07	.09	.12	.17	.23	.30	.44	.57
10	65	8	.08	.11	.14	.16	.22	.28	.36	.51	.65
15	70	10	.10	.13	.16	.19	.25	.31	.40	.55	.70
20	73	11	.11	.14	.17	.20	.26	.32	.42	.57	.73
30	76	12	.12	.15	.18	.21	.28	.34	.44	.60	.76
50	78	13	.13	.16	.20	.23	.29	.36	.46	.62	.78
60	79	14	.14	.17	.21	.24	.30	.37	.47	.63	.79
120	84	15	.15	.18	.22	.25	.32	.39	.50	.67	.84
180	90	17	.17	.20	.24	.28	.35	.43	.54	.72	.90

COMPARISON OF OBSERVED COEFFICIENTS OF RUN-OFF WITH COEFFICIENTS FROM DIAGRAMS 2 AND 3

	% Imp.	Time Min.	Obs. C	Diagram C	Diagram Used
1—Iowa	0	180	.037		
1—Iowa	0	180	.057		
1—Iowa	0	180	.093		
1—Iowa	0	180	.096	.10	3
2—Chicago, Ill.	7.6	120	.17	.14	3
3—Winnetka, Ill.	10	60	.22	.20	2
4—Rochester, N. Y.	15	44	.16	.21	2
5—Manchester, Eng.	18	12	.20 to .29	.20	2
6—Terre Haute, Ind.	18.5	70	.24	.20	3
6—Terre Haute, Ind.	18.5	70	.16 to .24	.20	3
7—Evanston, Ill.	20	40	.22	.23	2
8—Chicago, Ill.	22	55	.23	.20	3
9—Newton, Mass.	23	20	.28 to .43	.25	2
10—Cambridge, Mass.	28	20	.14 to .50	.28	2
11—Cambridge, Mass.	29	40	.19	.21	3
12—Rochester, N. Y.	30	26	.26	.29	2
13—Rochester, N. Y.	30	24	.37	.32	2
14—Providence, R. I.	34	24	.30	.32	2
15—Milwaukee, Wis.	35	80	.38	.37	2
16—Cambridge, Mass.	36	20	.23 to .62	.34	2
17—Louisville, Ky.	36	80	.32	.31	3
18—Rochester, N. Y.	38	23	.35	.36	2
19—Rochester, N. Y.	38	16	.32	.33	2
20—Washington, D. C.	60	25	.48 to 1.00	.49	2
21—Wilmington, Del.	65	20	.79	.51	2
22—Philadelphia, Pa.	67	40	.70 to 1.74	.55	2
23—New York, N. Y.	90	15	.36 to .84	64	2
24—Birgh, Eng.	100	10	.96 to 1.26	.65	2

It is a problem of economics and insurance that the skilled engineer must apply to each individual case.

The fact that such judgment must be used in sewer design, does not, however, mean that sensible results can be secured by offhand conclusion, even by an expert; rather it emphasizes the need for the logical and scientific analysis which we have suggested.

THE ESTABLISHMENT OF ENGINEERING STANDARDS FOR MUNICIPAL FIRE FIGHTING FACILITIES

By Clarence Goldsmith, Assistant Chief Engineer, National Board of Fire Underwriters, 209 W. Jackson Blvd., Chicago, Ill.

The general subject of standardization has been receiving the attention which it merits in recent years, having attained a considerable impetus during the World War. The establishment of the major portion of standards devolves directly or indirectly on the engineer as he by training and experience possesses the knowledge to develop them, and he naturally approaches the innumerable problems involved with enthusiasm, as none other can appreciate the value of standardization from the standpoint of economy and efficiency as fully as he.

Principal Facilities Involved

It has only been during the past score of years that the problems involved in connection with municipal fire-fighting facilities have received any considerable attention of engineers. The principal facilities involved are the water supply, fire department, and fire alarm, and the requirements imposed on these are dependent to a greater or lesser degree on the building laws, ordinances governing the hazards, and the existing structural conditions, and these in turn, on the functioning of the police department.

Prior to that time the water supply had necessarily received the attention of the engineer on account of the problems involved, but only minor consideration was given to the fire protection requirements, perhaps mainly because no uniform requirements had been established. The development of fire departments was similar to Topsy—they "just growed." Fire alarm systems were developed principally by the several manufacturers engaged in the building of instruments and their sale and installation. Building laws were brief, and did not keep pace with the development of the building art. Numerous new hazards developed much in advance of the ordinances to safeguard them.

The Baltimore Conflagration of 1904 brought home forcibly to the fire insurance companies the fact that the fire hazard of the congested value areas of our American cities called for an expert study to determine standards for their fire protection, because such conflagrations presented a menace to the fire insurance business and a more serious menace to the financial structure of the country.

The "Committee of Twenty"

A Committee on Fire Prevention had been maintained by The National Board of Fire Underwriters since 1892, but its activities were small in scope. The functions of this committee were delegated to the "Committee of Twenty" under the direction of which an engineering corps was organized, and investigations of the fire-fighting facilities of a number of the larger cities in the country were made. The importance of this work soon became apparent and the work was placed on a permanent basis under the direction of The Committee on Fire Prevention and Engineering Standards which now maintains a corps of over 30 engineers besides a stenographic force. The National Board of Fire Underwriters' main office is in New York and branch offices are in Chicago and San Francisco.

A Beginning of Standardization

In 1912 nearly 200 cities had been investigated and reports had been prepared. The considerable data then collected appeared to be sufficient to warrant starting the formulation of standards, and the work was continued for the ensuing four years, use being made of supplementary data gathered from about 100 additional cities inspected during this period, as well as data collected by rating bureaus in smaller cities and towns. Coincident with the establishment of the various standards, a grading schedule was developed to determine the relative class of fire protection in any city or town. The "Standard Schedule for Grading Cities and Towns of the United States with Reference to their Fire Defenses and Physical Conditions" was published in 1916. This schedule is based on and contains the standards determined upon. There are 129 distinct items considered, and each item involves one or more standard requirements. Up to the year 1923 the schedule had been applied to 4,334 cities, those having populations in excess of 20,000 being graded by engineers of the National Board, and the smaller cities and towns by engineers of the several rating bureaus. It was found desirable to make a few minor modifications in the standards originally established, partly due to the advance in the art of fire protection, and partly due to additional information obtained by the general application of the schedule, and therefore a new edition was issued in 1923.

Public Officials Endorse Standards

The standards contained in the schedule have been in general concurred in by water superintendents, fire chiefs, fire alarm superintendents, police chiefs, building inspectors, fire marshals, and architects, as well as by consulting engineers, and manufacturers of equipment. Some of the standards involved do not lend themselves to exact determination, but once established, the validity of the schedule is not affected. As an example, the meter—the unit of long measure of the metric system—is one ten-millionth part of the distance measured on a meridian of the earth from the equator to the pole. If the meter, the master gage of which is carefully housed and guarded in Paris, is not exactly one ten-millionth of the meridian, it would not affect the utility of the metric system in the slightest degree.

An Adequate Water System

Some of the more important standards for fire protection will now be discussed. In order that a water system may be adequate, it must be able to deliver the full required fire flow, in addition to the maximum 24-hour domestic consumption rate, into any area being considered. The fire flow required in the principal mercantile district of any city is determined by the formula.

$$G = 1{,}020\sqrt{P}\left(1 - .01\sqrt{P}\right)$$

Where G=gallons per minute and P=population in thousands. This quantity provides for probable loss from broken connections incident to a large fire.

The formula was prepared after a very careful study by the engineers of the National Board to give the fire flow required to care for most severe fire conditions in most of the large cities in the United States, and was first incorporated in a paper presented before the American Water Works Association by Metcalf, Kuichling and Hawley, who carefully reviewed the figures and compared them with other authorities. The quantity required by the formula is that considered necessary for a very severe block fire or two simultaneous fires of considerable magnitude.

It is not considered that this capacity will be sufficient to furnish all the water used and wasted during a conflagration involving a large part of the business district. It is true that the fire flow required is dependent upon the structural conditions, but on account of the similarity of structural conditions in practically all American cities, it has been found that more satisfactory results are ob-

tained by basing the fire flow on the population.

Water Capacity

Attention is called to the fact that maximum daily consumption is used in determining the adequacy of a system and not the maximum hourly rate.

In order that a water system may be normally adequate in capacity, in accordance with the standard, the source of supply, intake, suction lines, low-lift pumps, compressors, high-lift pumps, boilers, stacks, filters, and supply mains must each, in such combination as they may occur, be of sufficient capacity to maintain the required rate over a 10-hour period.

Water Reliability

The standard of reliability for number and capacity of pumps is that with the two largest pumps out of service, the remaining pump capacity shall be such as to maintain maximum daily consumption and fire flow at required pressure. The adequacy of pump capacity may be dependent upon high-lift and low-lift pumps, compressors, electric generators, or other separate and distinct units; each group performing a given function must be considered separately.

In order that the reliability of supply mains as affecting adequacy may be standard, a single break in the suction or gravity lines to pumping stations, flow lines from reservoirs, force mains, and main arteries must not reduce the available supply below the rate required to furnish maximum domestic consumption and fire flow at the required pressure.

Valves and Hydrants

The standard for valve spacing requires that supply mains be cross-connected and gated about once a mile, the larger arterial mains of the distribution system be gated so that not more than one-fourth mile will be affected by a break, and the other mains in the distribution system be equipped with a sufficient number of gate valves so located that no single case of accident, breakage or repair to the pipe system will necessitate the shutting from service a length of pipe greater than 500 ft. in high value districts or greater than 800 ft. in other sections.

Number of Hydrants

The number of hydrants required is dependent on the fire flow required, and the standard established is that they shall be so spaced that two-thirds of the fire flow can be concentrated on any block or group of buildings through hose lines, none exceeding 600 ft. in length for pumper supply and 500 ft. in length for direct hydrant hose streams. This requires the following hydrant distribution:

Fire Flow Required Gals. per Min.	Aver. Area per Hydrant, Sq. Ft.
Engine Streams.	
1,000	120,000
3,000	100,000
5,000	85,000
7,000	70,000
10,000	48,000
12,000	40,000
Direct Hydrant Streams.	
1,000	100,000
2,500	78,000
5,000 and over	40,000

Hydrants to comply with the general standard established for municipal service shall be able to deliver 600 gals. per minute, with a loss of not more than 2½ lbs. in the hydrant and a total loss of not more than 5 lbs. between the street main and outlet; they shall have not less than two 2½-in. outlets and also a large suction connection where engine service is necessary. They shall be of such design that when the barrel is broken off the hydrant will remain closed. Street connections shall be not less than 6 ins. in diameter and shall be gated. Hose threads on outlets should conform to the National Standard.

The foregoing are five of the thirty-one standards established for water systems. A few of the more important fire department standards will now be considered.

Fire Department Standards

The number of automobile engine or hose companies required in any city is determined by the formula $0.85+0.12P$, where P is the population in thousands, in cities having less than 50,000 population, and formula $3.4+0.07P$ in cities having populations of 50,000 to 200,000. This provides a sufficient number of companies so that one is within three quarters of a mile of every point in mercantile and manufacturing districts and within a mile and a half of any point in closely built residential areas. In some cities an excess of the above will be required, depending on the structural conditions found. Also the topography and general layout of some cities may require, for proper distribution, additional companies.

Automobile Ladder Companies

The number of automobile ladder companies required is determined by the formula $1+0.03P$ in cities having populations from 20,000 to 200,000, and in larger cities, the number will be determined by the required distribution which should be such as to provide a company within one

mile of every point in mercantile and manufacturing districts, within two miles of every point in closely built residential districts, and within three miles in scattered residential sections. An aerial ladder must be provided in a district where five buildings are four stories or higher, and one ladder truck in five shall be aerial.

Reserve Apparatus

Standards are also established for the number of reserve pieces of apparatus which should be provided to keep the existing fire companies in service. One reserve pumper should be provided for each eight engine companies or major fraction thereof required; one reserve hose wagon for each twelve hose companies or fraction thereof required, and one ladder truck for five or fraction thereof required.

Strength of Companies

The standard for the strength of companies is as given in the accompanying tabulation.

STANDARDS FOR STRENGTH OF FIRE COMPANIES.

Companies	Least Number of Men on Duty Daytime	Nighttime
Within or near any High Value District:		
Engine Company	7	9
Ladder Company	7	9
Hose Company	5	7
Water Tower Company	1	1
In Other Districts:		
Engine Company	5	7
Ladder Company	5	7
Hose Company	3	5

In the table the strength of engine companies is based on steam fire engines; one man less may be allowed in companies having automobile pumping engines, and the minimum may be decreased by one man in ladder companies have quick-raising aerial ladders. Four call men or eight volunteers are considered equivalent to one full-paid man, but only up to one-third the least number of men required to be on duty at all times. Credit is given for the men of the off-shift platoon for the number which the department records show respond on call in the same manner as for call men. These standards for manning are in general accordance with the ideas of the fire chiefs of the larger cities.

The standard for apparatus equipped with large chemical tanks, i. e. tanks having capacity of 35 gals. or more, is that sufficient number of pieces of apparatus be equipped with these tanks so that at least two pieces so equipped shall respond to each first alarm.

Hose Standards

In order that sufficient large hose may be provided with a capacity adequate to develop the required streams and provide for a sufficient quantity so that enough serviceable hose may always be available, the following standards have been established: Each engine or hose company shall carry at least 1,000 ft. of 2½-in. or larger hose, and shall be provided with a complete spare shift; hose companies responding to first and second alarms in mercantile or manufacturing districts, where direct hydrant hose streams are used, shall carry at least 500 ft. of 2¾-in. or 3-in. hose, the remainder being 2½-in.; engine companies and hose companies in other districts shall carry at least 200 ft. of 2¾-in. or 3-in. hose, and the remainder of the 1,000 ft. should be 2½-in.; and one or more of the reserve hose wagons shall be loaded with at least 1,000 ft. of 3-in. hose.

33 *Fire Department Standards*

Under the heading of fire department, 33 standards in all have been established, and in addition to those just described, some of the more important deal with the qualifications and appointment of officers and men, and provisions for their retirement; number of powerful stream appliances needed; the minor equipment which should be carried upon each piece of apparatus; methods of handling fuel; regulations for the enforcement of discipline; the assignment of apparatus for response to alarms; methods of drill and training; and provisions for making building inspections.

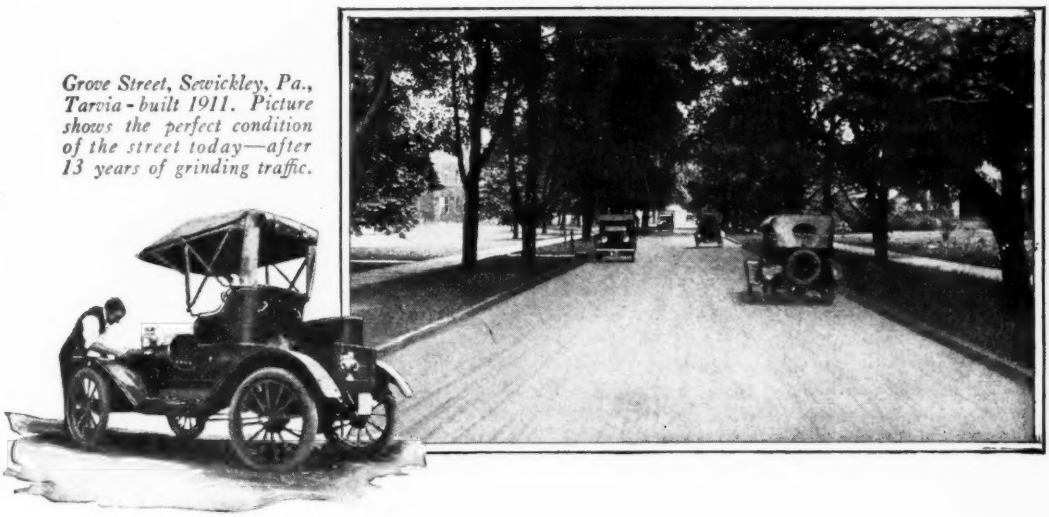
In connection with the fire alarm system, one of the most important standards is that the fire alarm headquarters building be of fireproof construction, contain no combustible material, and be unexposed or provided with ample and reliable protection against exposure.

Headquarters Equipment

The standards for headquarters equipment are that any system handling more than 400 alarms a year shall have provision for transmitting alarms manually, the automatic method of transmission being satisfactory for smaller systems. An automatic system shall have a repeating mechanism, manual transmitting apparatus, switchboard, repeater, and cable terminal. A manual system shall have receiving apparatus, transmitting apparatus, recording apparatus, control board, testing facilities, and cable terminal.

Circuit Standards

The standard for circuits is that they



Grove Street, Sewickley, Pa., Tarvia-built 1911. Picture shows the perfect condition of the street today—after 13 years of grinding traffic.

This car was modern in 1911 —the street still is

"HORSELESS carriages" we called them. Funny-looking contraptions, weren't they? Look at our picture. That top! That awkward rumble seat! Cars like this disturbed the peace and quiet of Sewickley, Pa., back in 1911—the year when Grove Street was Tarvia-built.

Thirteen years ago! Yet this Tarvia-built street is still in perfect condition in spite of years of traffic.

Tarvia streets can be maintained indefinitely at little cost—only economical maintenance is needed to make a Tarvia pavement last indefinitely. And in addition:

A Tarvia pavement will not wave, roll or rut.

A Tarvia pavement will remain skidproof because of its granular surface.

Thousands of Tarvia streets and roads have proved to taxpayers that—for the money spent—Tarvia gives more miles and the most years of satisfactory highway service. Every paving requirement—construction, repair or maintenance—can be met with Tarvia.

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New York	Chicago	Philadelphia	Boston
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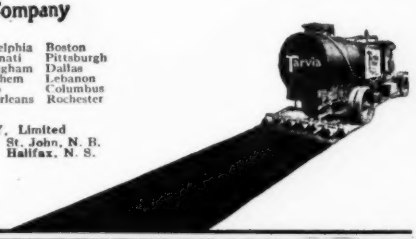

be underground, the wire to be not less than No. 12 gage for a single conductor, or less than No. 14 for two or three conductors, and No. 16 gage for four or more conductors. Wires shall have rubber insulation and shall be protected by lead sheath. Inasmuch as it is impracticable to install the entire circuit mileage of any system underground, standards have been established for overhead wiring. Aerial wires shall be not less than No. 10 gage copper, or No. 12 gage copper-clad steel with double or triple-braid weatherproof insulation.

Fire Alarm Boxes

The standards covering fire alarm boxes are as follows: That not more than 20 boxes shall be dependent on any box circuit; boxes shall be non-interfering and succession; boxes shall be so located that one will be within at least 500 ft. of every building in mercantile and manufacturing districts, and 800 ft. of every important group of buildings elsewhere; boxes in high value districts shall be indicated by red lights at night, and boxes in other districts shall have a distinguishing band painted on the supporting pole; all boxes shall be painted red as often as needed; and boxes shall be timed so that the alarm will be transmitted at a speed of not less than one stroke per second.

Telephone Alarms

The transmission of alarms of fire by telephone can in no way be considered as satisfactory as their transmission over a fire alarm telegraph system; however, owing to the wide distribution of telephones, a considerable portion of alarms are being received by means of telephones in nearly every city. Standard means shall be provided for handling these alarms so that undue delay and mistakes may be reduced to a minimum. Telephone alarms shall be transmitted from the public exchange through the fire alarm headquarters. At least one circuit should be reserved between the telephone exchange and the fire alarm. headquarters for the transmission of fire calls. At the public exchange the supervising operator or other responsible employee shall verify the location and oversee the transmission of fire alarms. When an alarm of fire is received at fire alarm headquarters over the telephone, the operator shall call the nearest fire company over the department telephone circuit provided for this purpose and shall notify that company of the location of the fire. The number of the nearest box shall then be set up on the manual transmitter, and the alarm sent out over the alarm circuits of the fire alarm system, so that all fire companies may know the location of the fire, and that those assigned to regular box alarm response may proceed to the fire.

Building Construction

The standards for building construction are contained in the Building Code Recommended by The National Board of Fire Underwriters. This code was developed and is kept up to date by the Committee on Construction of Buildings of The National Board of Fire Underwriters which employs a consulting engineer and staff for this purpose. The code prescribes standard limitations for heights and areas, protection to exposed windows, protection to vertical openings, protection to communications through fire walls; prohibits frame construction within fire limits; and gives standards for wall thicknesses, construction of chimneys and heating apparatus, improved construction, private fire protection, construction of fire stops, fire escapes, parapets, and the quality of materials and workmanship.

All large cities now have comprehensive laws governing the hazards. The National Electrical Code, prepared and sponsored by engineering societies, insurance organizations, and manufacturers of electrical equipment, and generating companies, is universally adopted as the standard for electrical construction. Engineering representatives of The National Board of Fire Underwriters are members of the committee which prepares the code.

The National Board publishes regulations covering the various hazards. These regulations are prepared and kept up to date by committees of the National Fire Protection Association. These committees are composed of insurance engineers and representatives of the manufacturers and distributors of the various materials considered. The more important of these regulations comprise those covering oil lighting and heating, gas lighting and heating, inflammable liquids, hazardous chemicals, carbide, garages, dry-cleaning, nitro-cellulose and films, motion picture machines and booths, explosives, fireworks, matches, combustible fibre, lumber and packing materials, and rubbish, trash, ashes, bonfires, etc.

The foregoing paper by Mr. Goldsmith was presented before the 1924 meeting of the Illinois Society of Engineers.

Contracts Awarded

ROADS AND STREETS.

Ala., Abbeville—State Hwy. Dept., Montgomery, awarded contract to H. N. Bentley for 20 miles state rd. from here to Houston Co. line thru Tumbleton and Headland, at $129,483; J. R. and J. G. Miller, at $25,144 for bridge.

Ala., Anniston—Morgan-Hill Paving Co., Birmingham, Ala., awarded contract for 23 blocks street paving at $258,000.

Ala., Clanton—Following contracts let by State Hwy. Dept., Montgomery; at $600,000 for grading, draing. structs. and concrete surfacing 17.4 miles of road in Chilton—Shelby Co. line to Clanton: Surfacing to Speed-Parker, Inc., Louisville, Ky., at $412,532; grading, to W. A. Taylor, Sylacauga, Ala., at $119,021; bridges to W. T. Weaver, Collinsville, Ala., at $22,392.

Ala., Eutaw—State Hwy. Comn., let contract for improving highway connecting Eutaw and Gainesville: To Morgan & Hill, Birmingham, Ala., at $201,500, for surfacing; Lamb & Lemore, Eutaw, at $66,060 for bridges; Thompson & Co., Fayette, Ala., at $142,011, for grading and culverts.

Ala., Florence—Uvalde Paving Co., Dallas, awarded contract to pave with rock asphalt 70 blocks of streets at $200,000.

Ala., Tuscumbia—Southern Roads Co., Birmingham, Ala., awarded contract by City for 36 blocks street paving and more than 2 miles sidewalks, at $151,000.

Ariz., Phoenix—Phoenix-Tempe Stone Co., Phoenix, awarded contract for constr. of Sec. A of White Star—Congress Jct. Hwy., FAP 72, at $161,769.

Ariz., Phoenix—Pacific Constr. Co. Phoenix, awarded contract for constr. of State Hwy. bet. Buckeye and the Hassayampa river, FAP 71, at $150,225, involving excavation and conc. pavement.

Ark., Rogers—Kaw Paving Co., Topeka, Kans., awarded contr. to pave 11 blocks in business dist. 6-in. base 1-in. sand and layer of vit. brick, 1-in. asph. covering, at $100,853.

Cal., Burbank—Geo. A. Simpson, Olson Bldg., Burbank, awarded contract for improving Pioneer Ave., at $109,101.

Cal., Hawthorne—Geo. H. Oswald, 366 E. 58th St., Los Angeles, contract for paving Acacia and Birch Aves.—Ballona to Wallace Sts.—with Willite pavement at $236,613.

Cal., Sacramento—Geo. N. Oswald, 366 E. 58th St., Los Angeles, contract at $183,863 for constr. of section of State Hwy. Los Angeles Co.; abt. 2.8 mi. long, to be paved with conc. and surfaced with a sph. concrete.

Cal., San Diego—California Constr. Co. Union Bldg. awarded contr. for impvt. of Woodman Ave. and N St., involving 206,196.1 sq. ft. 1½-in. Warrenite on 3-in. bitum. base; total $52,065; David H. Ryan, 1615 Fern St. contract for impvt. of State St. Reynard Way and Goldfinch St. at $47,-441.

Fla., Ft. Myers—Morgan-Hill Paving Co., Jacksonville, awarded contract by Lee County Commrs., at $1,000,000 for 5 roads totaling betw. 50 and 60 miles: 24 mi. Tamiami Train; 20 miles from Ft. Myers to Lee-Henry Co. line, up Caloosahatchee River; 6 mi. on State Hwy. 2 from connection with up-river road Olga, to Lee-Charlotte Co. line; all 16-ft. hard surf.; 2½-in. penetration asphalt on rock, shell or marl base; Pine Island road and bridge connecting Ft. Myers and mainland with group of islands off coast; road from Crescent Beach.

Fla., Tampa—Cone Bros. Tampa, awarded conteract for paving; 24-ft. blk. paving on rock base on Covodonga St. Bayshore Blvd. to Cardenas Ave.; Morrison Ave.—Howard to Henderson Blvd.; both 2 miles long; Azeele St.—Howard Ave. to Old Tampa Bay; all in Palma Ceia Park section; also to pave several blks. on Elm St. and Green; one-half mile from Lutz road in Sulphur Springs section; total contract price $375,000.

Idaho, Twin Falls—C. A. Robinson, local, awarded contract by State Hwy. Supervisor H. W. Gregory, for grading and graveling span of approx. 23 miles on Old Oregon Trail state highway betw. pavement at Hansen and gravel road west of Burley, Idaho, at $150,165.

Ill., Springfield—Following contracts let by Dept. Public Wks. and Bldgs., May 1st to May 15, 1924: SBI Rt. 3, Sec. 59, Jersey-Madison Cos., (paving) to Nelson Bros. Co., Jerseyville, Ill., at $146,302; Rt. 3, Sec. 60, Madison Co. to Edwardsville Constr. Co., Edwardsville, Ill., at $97,969; Rt. 1, Sec. 7, Edwards Co. to Harry A. Carpenter, Terre Haute, Ind., at $90,347; R. 12, Sec. 24, Clinton Co. to Otto Allenthorpe & Co. Casey, Ill., at $67,938; R. 36, S. 1, Hancock-Adams Cos. to Edw. J. Eiff Co. Quincy, Ill., at $139,699; R. 9, S. 34, McDonough Co. to Jos. Kesl & Son, Edwardsville, Ill., at $42,-408; R. 26, S. 8A, Lee Co. grading to Jno. B. Drew, Tampico, Ill., at $17,571.

La., Baton Rouge—City let following contracts to pave streets: Southern Roads Co., Birmingham, Ala., 79,000 sq. yds. 2-in. Warrenite-bitum. 5-in. conc. base; Valicant & Toomey, Ft. Worth, Tex., 12,000 sq. yds. 3-in. brick; 5-in. conc. base and 9,150 sq. yds. 4-in. brick, 6-in. conc. base. 46 streets at total of $378,098.

Maine, Augusta—Boone and Brewer, Presque Isle, awarded contracts for graveling State Hwy. K Spur in following towns: Easton, $50,759; Lincoln, $50,074; Smyrna, $33,294; M. Hughes, Bangor. State Hwy. D in Edgecomb, $88,281; McCabe & Giovannini, Boston, Mass., St. Hwy. N in Edmunds, at $65,585; A. D. Bridges Sons Inc. Hazardville, Conn., bitum. macadam pavement in Raymond at $78,269; Arborio Rd. Constr. Co., Hartford, Conn., State Hwy. B. Brighton, at $104.

Mass., Boston—M. F. Gaddis, awarded contract for laying bitulithic pavement and sewerage works in Shawnut Ave.—Warrenton Street to Roxbury St.—at $205,317.

Mich., Lansing—Hill & Belknap, awarded contract by State Administrative Board, for M-25 in Northern Peninsula from Munising to Sault Ste. Marie (55 miles, at $461,000. Hill Bros. have contract to do most of the grading; other contracts for grading let as follows: J. F. McNicholas, 14.185 mi. sec. 8, Schoolcraft Co.; Nels. Bye 4.994 mi. sec. 12-B; Chippewa and Groves & Sons Co. 13.284 mi. sec. 15BD, also in Chippewa. M. J. Bacco, Iron Mtn., awarded contract to surf. 5.02 mi. with bithulithic asph. FAP at Marquette; Smith, Sparks Constr. Co., Houghton, contract for 7.34 mi. Ontanagon Co. M-26, (stamp sand) at $115,446.

Mich., Lansing—Mich. Fed. Aid contracts let as follows: Rd. 109, Marquette Co. Skandia Twp. Cl. E-Bit. 16 ft. wide, 5.020 mi. to M. J. Bacco, Iron Mountain, Mich., at $111,927; 73-C, Monroe Co. LaSalle Twp., Cl. grading and shaping 0.208 mi. to State Construction Co. at $4,480; FA 97-A, Oakland Co., Waterford and Independence Twps. Cl. 7-in. F. Std. 20 ft. wide, 4.746 mi. to Willite Rd. Const. Co. Detroit at $104,138; 113-C, Kent Co. Lowell, Cascade, Ada and Grand Rapids Twps. Cl. 7-in. F. Std. 20 ft. wide, 13.853 mi. to G. P. Scharl, Grand Rapids, at $212,498.

Miss., Greenwood—E. A. Finch, awarded contract for concrete base and brick paving at $208,-705; Pierce & Beeman, Greenwood, awarded contract for curb and gutters at $18,147.

Nev., Carson City—Ken Hodgman, Reno, awarded contract by State Hwy. Dept., for improving state highway in Lander Co., 18.02 miles grading and gravel surfacing bet. Campbell Creek ranch and Summit of Railroad Pass, at $91,158; Fred Coolidge, Fallon, awarded contract for constr. of state hwy. in White Pine Co. 13.65 miles grading and graveling, at $86,608.

N. Y., Albany—Maxwell Webber Constr. Co., Ionia, Mich., awarded contract for paving job near Buffalo, at $300,000.

N. Y., New York—Granite blk. repaving 10th Ave. to J. Meehan & Son, 74 Cortlandt St., at $274,548. West 180th St., to Asphalt Constr. Co. 208 Bway., at $26,606; grading, curbing and flagging W. 184th St., etc. to J. McCarthy, 551 Exterior St., at $4,164.

N. Y., Poughkeepsie—Spoor-Lasher Co., Inc., 54 Market St., awarded contract for grading, curbing, paving, etc., 17,400 sq. yds. Reservoir Sq., Fountain Pl., Lexington and Manitou Aves., Montgomery, Cannon, So. Clinton and Church Sts., at $103,055.

N. C., Greensboro—Murray Construction Co.,

Knoxville, Tenn., awarded contract to widen and pave Greene St. with sheet asphalt on 6-in. conc. base; 22,000 sq. yds. widening and paving; 7,200 ft. stone curb at $490,000.

N. C., Wilson—R. G. Lassiter & Co., Oxford, N. C., awarded contract for various impvts. as follows: Curb, gutter and sidewalks, $94,970; conc. found. for 59,000 sq. yds. paving streets, $67,850; top-dressing for street pavement, either $75,520 or $85,550 depending on surf. material used.

Okla., Okla. City—State Hwy. Dept. let contracts for four road projects as follows: F. A. 117, Muskogee Co. 10 mile gravel—Warner to Webbers Falls, to Maney Bros. Okla. City, at $110,-561; bridge to Granville, Hamblin Co., Muskogee, $28,927; Pittsburgh Co. 2 secs.; 119 7½ mi. conc. to Smith Bros. Dallas, Tex., at $218,259, 120, 4½ mi. conc., to Smith Bros. at $140,841; State Aid No. 1, Ottawa Co., less than ¼-mile so. of Miami, Topeka top to General Contracting Co., Okla. City, at $4,087.

Ore., Medford—S. S. Schnell, Grants Pass, awarded contracts for construction of two roads, at $156,832.

Pa., Harrisburg—Contracts let by State Hwy. Dept., Harrisburg, for conc. roads: 11,951 sq. yds. Application 2659, Bucks Co. to Ross & Whalen, 471 Southard St., Trenton, N. J. at $43,778; 66,777 sq. yds. Rte 7, Butler Co., Rood Constr. Co., Butler, at $343,145; 66,040 sq. yds. Rte. 146, Montgomery Co. to Union Paving Co., 30th and Locust Sts. Phila., at $267,894; 36,580 sq. yds. Rts. 226, Lehigh Co. General Paving Co. Allentown, at $162,-660.

Penn., Washington—Washington County let contract for construction 8,939 ft. McMurray Rd. to Hardy and Rankin Canonsburg, at $74,487; 10,350 ft. 84-Rd. to J. Herd, Washington, at $83,510; 3,600 ft. Pike Run Rd., to Donora Constr. Co., Donora, at $39,699; 5,280 ft. McClames Bridge-Meadowlands Rd. to W. K. Reed & Co., Waynesburg, at $45,-476; 9,400 ft. Short Creek Rd. to Petriello Bros., Brownsville, at $75,015.

S. D., Pierre—Following road and bridge work let by State Hwy. Dept.: Grad. FAP 95B, Faulk Co. 15.6 mi. at $41,256 to Dowd Bros. & Schreiber, Watertown, S. D.; Grade FAP 160, Brookings, Moody Co. 13.49 mi. $45,102 to Enke Constr. Co. Co. Lake Benton, Minn.; Grade FAP 173A, Faulk Co. 1.52 mi. at $4,951, to Dowd Bros. & Schreiber, Watertown; grade FAP 179, Deuel Co. 11.52 mi. at $44,309 to Ira C. Cox, Sioux Falls; grade FAP 172-A, Edmunds Co., 15.09 mi. at $46,537 to Bert O'Rourke, Aberdeen; Grade FAP 162A, Haakon Co., 11.21 mi., $42,876 to W. R. Larson, Sioux Falls; grade FAP 170D, Minnehaha Co., 14.03 mi., $44,733 to Tobin and Maloney, Madison; grade FAP 135B, Minnehaha Co. 1.38 mi. $29,810 to W. R. Larson, Sioux Falls; grade FAP 138B, Law-Meade Co., 4.58 mi., $34,891 to N. J. Olson, Wall; grade FAP 177A, Pennington Co., 22.44 mi., $104,091 to R. P. England, Murdo; grade FAP 164 Brook-Moody Co., 18.66 mi., $63,454 to Enke Constr. Co., Lake Benton, Minn.; grade 95C; Faulke Co. 8.3 mi. at $18,534 to Dowd Bros. & Schreiber, Watertown; grade FAP 158A, Clay Co., 9.98 mi. to Tobin & Maloney, Madison, at $27,404; Grade FAP 183A, Beadle Co., 18.56 mi., $61,001, to W. R. Larson, Sioux Falls; grade 176 Kingsbury Co. 12.09 mi. at $39,896 to Pioneer Bridge Co. Mitchell; grav. FAP 20B, Walworth Co., 6.17 mi., $11,560 to H. Pickus Co.; grav. FAP 49BC, Lyman-Brule Co. 5 mi., $7,295 to Tobin & Maloney, Madison; grav. FAP 500, Sanborn Co. 5.99 mi. $7,261 to Tobin & Maloney; grav. FAP 61B, Aurora and Brule Co., 13.35 mi. $21,492 to Tobin & Maloney; Grav. FAP 86, Sanborn Co., 6.58 mi. $12,117 to Tobin & Maloney; grav. FAP 88B, Meade Co. 8.73 mi., $156,252 to Tobin & Maloney; grav. FAP Hutchinson Co., 13.41 mi. $20,426 to Tobin & Maloney; grav. FAP 98, Lincoln Co., 13.86 mi. $23,-063 to Tobin & Maloney; grav. FAP 105B, Brown Co., 13.77 mi. at $24,968 to Tobin & Maloney; grav. FAP 116, Hutchinson Co., 15.16 mi. at $14,440 to Tobin & Maloney; grav. FAP 122, Deuel Co., 9.96 mi., $11,581 to Tobin & Maloney; FAP 129, Turner Co. 9.77 mi., $13,365 to Tobin & Maloney, gravel FAP 137, Lake Co., 5.46 mi., $6,312 to Tobin & Maloney; gravel FAP 140, Law-Meade Co., 7.47 mi., $11,866 to R. R. Wiley, Summit; gravel FAP 144, Union Co. 7.82 mi., $8,064 to Tobin & Maloney, Madison; grav. FAP 153, Union Co. 2.41 mi. $9,290 to Tobin & Maloney.

Tex., Baird—Tibbetts Construction Co., Mineral Wells, awarded contract to grade, construct draing. structs and lay rock base with asphalt macadam surf. on 9.62 mi. State Hwy. No. 1—Callahan-Eastland Co. line to point on Bankhead Hwy. at $250,-000.

Tex., Corpus Christi—Smith Bros. Inc., Dallas, awarded contract for 5½ miles hard surf. State Hwy. No. 12-A, from Robstown to Rabb, at $104,-808.

Tex., El Paso—El Paso Bitulithic Co., awarded contracts for 2 rd. projects as follows: North Loop, Warrenite-bitulithic, at $132,588; Womble Blvd., concrete at $67,412.

Wash., Longview—Olympic Construction Co., 1326 Borthlake Ave., Seattle, awarded No. 3 contract by the Long-Bell Lumber Co., local, involving about 37,000 sq. yds. cement conc. pavement at approx. $100,000.

W. Va., Charleston—Andrews Asphalt Paving Co., Hamilton, Ohio and Ebersbach Construction Co., Pomeroy, Ohio, awarded contract for 20,000 sq. yds. asphalt and brick paving, at $150,000.

W. Va., Logan—Hatfield Construction Co., Huntington, W. Va., awarded contract by Island Creek Coal Co., Holde, W. Va., for 9 miles hard surf. roads on Whitman's Crk. Tract Fork and Copperas Rts., at $310,000.

W. Va., Wheeling—Coss & Otto, awarded contract to pave McCulloch St.—Baker Street brdg. to 16th St.—at $82,847; H. L. Seabright, contract to pave Wood St.—36th to 43rd, and 43rd—42nd to 39th St.; Kaltenbach Bros. contract at $28,608 for 2 retaining walls on McCulloch St.; Stringer & Stringer Constr. Co. contract for curb along 18th St.; Cass & Otto contract for paving on S. York St.—all Wheeling.

Wis., Wausau—Hayes Bros., Janesville, awarded contract by State Hwy. Comn., for impvt. of Stevens Point—Wausau Rd., Proj. 38, at $134,751 (conc. surf.).

SEWERAGE AND SEWAGE TREATMENT

Cal., Alhambra—Culjak & Bebek (Culjak, 182½ N. Brannick St., Los Angeles) awarded contract by City Comn., for constructing new city sewer system at $96,410.

Cal., Los Angeles—Peter R. Gadd, Van Nuys Hotel, awarded contr. by Board of Public Works, for constr. of sewer in Main St.—Santa Barbara Ave. to Manchester Aves.—at $2,705,992; Stroud Bros. & Seabrook, 1607 W. Adams St. awarded contract for constr. of sewer in Ave. 47—129.5 ft. so. of York Blvd.—at $28,842.

Cal., Los Angeles—Chas. Thompson, 701 Brockman Bldg., awarded contract for constr. of portion of Sec. 7 of North Outfall sewer bet. Sta. 313 plus 50 and Sta. 331 plus 22.50, at $93,000; W. D. McCray, 416 American Bank Bldg., awarded contract for constr. of vit. pike sewer in Fernwood Ave.—Hyperion to Sanborn Aves.—at $3,480.

Ont., Toronto—Sewers in University Creek to J. O. Jerau, 90 Curzon St., at $86,548; St. Johns Rd. and 2 lanes to W. E. Taylor, 22 Falcon St. $423,497 and $797 respectively; lane no. of Lappin Ave., to Murphy Contg. Co. 8 Wychwood Ave., $726, Tyrell Ave. to W. R. Worthington, 57 Lascelles Blvd., $38,993, Wychwood Ave. and 2 lanes to Grant Contg. Co. 50 Front St. E. $3,395, $960 and $583, respectively.

Fla., Ft. Myers—Bryan & Co., Jacksonville, Fla., awarded contr. for san. and storm sewers; $146,000 available. Macon Sewer Pipe Works, Macon, Ga. contract for vit. clap pipe sewer.

Ga., Bainbridge—Dysard Construction Co. awarded contract for storm and san. sewers at $61,170.

Idaho, Pocatello—W. E. Kennedy Co. Salt Lake City, awarded contract for constr. of sewer in Impvt. Dist. (local) at $56,437.

Ind., Indianapolis—Following low bidders will receive contracts for various parts of sewer interceptor projects: Sheets & Canfield, Columbus, Ohio, $214,498; Columbia Construction Co., $161,111; Henry W. Miller, No. Vernon, $143,653. Contracts will be awarded following sale of bonds. The cost of constructing the 2 interceptors will be $519,-262.33.

Ind., Tell City—H. Rees & Son, Quincy, Ill., awarded contract for sewer in Fulton Street—$76,942.

Md., Baltimore—Ryan Constr. Co. 8 Light St. awarded contract for constr. of water drains in Dist. 48, Storm Water Contr. 66; 17,000 c.y. excav. 2,500 c.y. conc. masonry, 4,000 lin. ft. rein. conc. pipe drains from 24-54 in. diam., at $108,479.

Mass., Boston—Following contracts for sewerage works let by Public Works Dept.: Wm. Barrett & Co., works in Moore St. overflow outlet—Coleridge to Cowper Sts., E. Boston, at $9,977; Samuel J. Tomasello, wks. in Eliot Pl. at $1,905; V. Grande, bldg. Shepard brook, easterly branch, Everett St. private land and Hichborn St.—Everett to Arthur Sts. Brighton, at $33,031; John Guarino & Co. sewerage wks. in Corinne Rd.—existing sewer to end of street, Brighton at $1,737; De Cristofaro & Bros. Co., sewerage wks. in Cataumet St.—Pond St. to end of street, 260 ft. northerly, W. Roxbury, at $2,112; S. J. Tomasselo, sewerage works in Regina Rd. at $2,296; A. D. Daddario, sewerage works in School St., at $2,621; V. Barletta, sewerage works in Dorchester brook sewer, east fork, in Humphreys Street—Holden to Dudley Sts. Dorchester, at $53,860; C. Russo, sewerage works in Nottinghill R.—Melton Rd. to Nottinghill Rd. Brighton, at $12,368; C. & R. Construction Co. awarded contract for construction of sewerage works in Germantown Dist. West Roxbury and main outlet to State Metropolitan Sewer in Dedham, at $165,742.

Mich., Dearborn—Coffman-Crane Service, 708 Empire Bldg. Detroit, awarded contract for laying 9,247 ft. 12-42-in. vit. clay sewers in Mich. Ave. Dist. at $57,509.

Mich., Detroit—S. Healy, 6,466 Epworth Blvd., awarded contr. for sewer 4122 at $77,000; Sewer 4919 to Rennie & Dibble, 11565 Oakwood Ave., at $6,540; 1421 to Coffman-Crane Service Co., 708 Empire Bldg., at $6,911.

Mo., Cameron—Carothers Construction Co., Kansas City, Mo., awarded contract for disposal tank, filter beds, pumping station and sewer pipe, at $57,979.

Mo., Wellston—(St. Louis, P. O.) W. F. Riley & Son, Pontiac Bldg. St. Louis, awarded contract by St. Louis Sewer Dist. 3, for 8 and 36-in. sewers, etc., here and vicinity, at $67,000.

Neb., Fremont—Following contracts let: Conc. pipe, excav., etc., to Arthur Dobson Constr. Co., 809 First Natl. Bank Bldg. Lincoln, at $29,258; manholes, syphons, iron pipe, etc. to Wright Bros. Constr. Co. Fremont, at $25,300.

N. Y., Syracuse—Provo Bros. 103 Hiawatha St., awarded contract for sewer in Salina St.—East to Orange St.—at $100,725.

Ohio, Youngstown—F. George, Youngstown, awarded contract for sewers in Sec. 1 and about 7 miles Sec. 2, Coitsville Sewer Dist., at $107,343 and $73,346, respectively.

Pa., Phila.—Kober Construction Co., 34 S. 17th St., awarded contract for sewage treatment works, superstruc., for 1 sty., 27x42 ft., brick and steel locker bldg., also 1 sty. 65x114 ft. brick and steam heating plant at $22,950 and $86,000 respectively; mechanical equipt. for heating plant to Roberts Filter Co., Darby, at $87,490.

WATER SUPPLY AND PURIFICATION

Cal., Oakland—Bates and Borland, Bank of Savings Bldg., awarded contract by East Bay Water Company, 512 16th St. for Upper San Leandro Storage Project, including storage dam, earth fill type, 185 ft. high. 656 f t.long on crest, crest width 75 ft. base abt. 1,150 ft., 1,260,000 c.y. earthwork, spillways, tunnels, filtration plant, 36-in. riveted steel pipe line, at cost plus—about $3,000,000.

Que., Beauport—Town Council awarded following conttracts in $200,000 water works system: Excav. and installation of pipe to Dave & Davito, Neuville, Que., at $28,000; Engineers, $57,000; pipe, Kennedy Construction Co.; Edouard Hamel & Cie, Quebec, Engineers.

Ont., Timmins—McNamara Brothers awarded contract for 1924 water and sewer extensions here at $45,511. Figures include 1,500 c.y. rock (estimated) and 400 waterproof joints at units prices in bids. National Iron Works, Toronto have contract for supplying cast iron; Kerr Engine Co., hydrants and valves; Clay Products Works, New Liskeard, Ont., manhole covers, frames and special castings.

Ont., York Twp.—Contracts let by Twp. Council for furnishing following materials: Iron pipe to National Iron Co., $33,000; special castings, $2,000 to Worr Fdry. Co. 163 Sterling Rd.; hydrants, $7,000 to Jno. T. Hepburne, Ltd., 18 Van Horne St.; lead pipe and pig lead at $23,000 to Canada Metal Co., 39 Fraser Ave.; brass goods, $9,800 to Empire Brass Mfg. Co., 110 Adelaide W.; road oil, $650 to Imperial Oil Ltd., 56 Church St.; application of oil $1,500, Construction Co., 107 Hillside Ave., E.; crushed stone, $6,000 to Hagesville Crushed Stone Co., all of Toronto.

Fla., Cocoa—J. B. McCrary Co., Atlanta, Ga., awarded contract to install water and sewerage systems, at $190,000.

Fla., Ft. Myers—Elwood G. Ladd, Jacksonville, Fla. awarded contract for water main extension: Columbian Iron Works, Chattanooga, Tenn., fire hydrants and R. D. Wood & Co. Philadelphia, Pa. for valves; $80,000 available.

Ill., Danville—R. McCalman, Inc., Danville, awarded contract by Interstate Water Co., for dam (gen. contr.); tainter gates to Worden-Allen Co. Port Washington Rd., Milwaukee, Wis.; sluice gates to Coldwell-Wilcox Co., South End, Newburgh, N. Y. Engineers' est. $125,000.

La., Alexandria—Caldwell Bros., New Orleans, La., awarded contract for reservoir, at $56,250.

Neb., Kearney—Following contracts let for water works system: 3 wells to Well Works Mfg. Co. Garden City, Kansas, at $3,900; Engine to De La Varge Mach. Co. Kansas City, Mo., two 300 h.p. Diesel oil driven engines at $56,365; 3 horizontal water pumps to American Well Co. Aurora Ill. at $4,000; cast iron pipe to U. S. Cast Iron Pipe Co., $18,000; general contr. to Walter Knutzen & Son, Kearney, at $28,937; includes power house, pump house, bldg. reservoir, etc.

N. J., Berlin—Contract for artesian well to Redpath & Potter Co., 22nd and Cambria Sts., Phila., $2,532, 4 and 6-in. cast iron pipe, fire hydrants and special castings, to R. D. Wood & Co., 400 Chestnut St., Phila., at $76,126; 8, 10 and 12-in. cast iron pipe to U. S. Cast Iron Pipe and Fdry. Co. 1421 Chesnut St., Philadelphia, $35,067; valves and boxes to Rensselaer Valve Co., 50 Church St., New York City, at $4,841; steel standpipe to Chicago Bridge and Iron Works, 30 Church St., New York City, at $10,490; standpipe fdn. to R. R. Fernow, Cynwid, Pa., at $3,500; excav. and laying pipes to E. F. Berga, 440 Cartaret St., Camden, at $49,187.

N. Y., Burdett—Lehigh Valley R. R. Co., 143 Liberty St., New York City, will build concrete reservoir and engine water supply system here, by Day Labor. Est. cost $100,000. G. T. Hand, Chf. Engr.

N. C., Robersonville—Boyd, Higgins & Goforth, Realty Bldg., Charlotte, awarded contract for two 8-in. deep wells, 100,000 gals. steel tank and tower, 75,000 gal. conc. storage reservoir, necessary pumping equipt., septic tank, 32,000 ft 2-10 in. cast iron mains, 22,600 ft. 8-10 inch sewer lines, at $92,000.

N. Car., Wilson—R. G. Lassiter, Oxford, N. Car., awarded contract for laying water mains and sewers at $20,743 and $31,797 respectively.

O., Cleveland—J. Connelly Constr. Co., 7016 Euclid Ave., awarded contract for 1,875 tons 60-in. cast iron mains in Woodland Ave. Sec. 30 W, at $184,267.

O., Shaker Heights—(Cleveland, P. O.)—Hanna & Michael, 2259 Cedar Ave., Cleveland, awarded contract for 7,555 ft. 6 and 8-inch cast iron mains in 4 streets, at $22,221; Scottsdale Rd. (West section) to A. Marra Construction Co., Ulmer Bldg., Cleveland, at $15,188; 7 streets to Great Lakes Constr. Co., Hickox Bldg., Cleveland, at $45,643. Work on latter 2 projects involves 23,120 ft. 6 and 8-inch cast iron pipe.

Okla., Cushing—National Cast Iron Pipe Co., 903 Commerce Bldg., Kansas City, Mo., awarded contract for Delavaud pipe for water works and sewers, at $115,744.

Tex., Denison—Brooks Construction Co., Dallas, Tex. awarded contract to rebuild damaged sec. of Lake Dam, at $30,000.

Texas, Ranger—Chicago Bridge and Iron Co., Praetorian Bldg., Dallas, awarded contract for standpipe and wash water tank, at $25,000.

Tex., Snyder—J. B. Winslett, 1001 Main St., Dal-

las, awarded contract for water and sewer extens., at $37,965.

Wn., Seattle—F. N. Badolato, awarded contract for water mains in N. 42nd St., et al, at $64,920; in 48th Ave., so. et al, at $6,842.

Wis., Hurley—Layne-Bowler Chicago Co., 37 W. Van Buren St., Chicago, awarded contract for water works impvts. pumping and supply station, at $42,000.

Prospective Work

ROADS AND STREETS

Ala., Birmingham—W. E. Dickson, Commr. Pub. Impvts. plans $1,000,000 paving program: 30 blks. paving in Ensley, $200,000; 7th Ave.—14th St. to 10th Ave., and from 28th to 49th, approx. $300,000; complete Pratt City-Birmingham Rd., $70,000, County to pay 65 per cent.

Ala., Montgomery—City Commission plans to pave 12 streets. Contemplates $100,000 bond issue. W. A. Cone, City Engineer.

Ark., Little Rock—State Hwy. Dept., Little Rock, plans 200 to 300 ft. road bldg. in northwestern Arkansas to supplement highway over Boston mountain to Winslow and other points in the Ozarks. W. W. Mitchell, State Hwy. Engr.

Cal., Los Angeles—Co. Rd. Commr., Geo. W. Jones, has recommended Supervisors that San Fernando Blvd.—Oxford Ave., to Huron Street—be repaved. Proposed paving will be 1½ in. Warrenite-bitulithic on 7-in. conc. base, 54 ft. wide. Total est. cost $350,000.

Cal., Pomona—According to F. C. Froehde, City Engineer, first work to be done under new $400,000 street bond issue (voted at recent election) will be E. Holt Ave. W. Holt Ave., S. Garey Ave. and Towne Ave. Issue will make possible approx. $800,000 street work.

Cal., Sacramento—There is now available approx. $2,702,600 for impvt. of highways in various counties of the San Joaquin valley in immediate future. Of this sum, $1,500,000 will be spent in Kern Co. for resurfacing highways and constructing new roads. In Fresno Co. $30,000 is available, while another $300,000 will be spent on hwys. to be built under Rd. Impvt. Dist. plant. Merced County has $50,000 for perm. bridges and another impvt. dist. $400,000 available in San Joaquin Co. for bridge and hwy. constr. $62,600 in Stanislaus County avail. for new highway constr., $10,000 in Kings County.

Cal., San Diego—City Engr., F. A. Rhodes has completed plans for paving El Cajon Blvd. bet. Park Blvd. and Boundary St., involving 245,827 sq. ft. bitum. base paving, 285,827 sq. ft. conc. base, 34,993 sq. ft. sidewalk. Resolution adopted by Council to improve Mission Blvd., Pacific Ave., and Cass St. involving 444,971.44 sq. ft. paving with 5-in. cem. conc.; 19,097.94 lin. ft. 8-in. conc. curb; 44.30 lin. ft. 6-in. conc. curb; 120 lin. ft. 12-in. 16 gauge corr. iron pipe culvert; 25 lin. ft. 12-gauge part circle corr. iron culvert; 245 c.y. rock fill; also to improve Normal St., Center and 11 other streets involving 505,508.99 sq. ft. paving with 2½ in. bitum. base and 1½-in. asph. conc. top; 340,374.40 sq. ft. paving with 4-in. cem. conc. base and 3-in. asph. conc.; 7,808 lin. ft. 6-in. conc. curb; 1,680.19 lin. ft. 8-in. concrete curb; 1,787.59 sq. ft. cem walk; 50 lin. ft. 16-in. 16 gauge corr. iron pipe drain; 52 lin. ft. 12-in. d.s. cem. conc. pipe culvt.; 50 lin. ft. 16-in. d.s. cem. conc. pipe culvt.; 20 lin. ft. 18-in. 16 gauge corr. iron pipe culvert; 5 4-in. cement pipe sewer laterals; two 6-in. cem. sewer laterals; also to improve First St.—Maple to Olive Sts.—by grading and constructing cem. conc. walks curbs, catchbasins, 12-in. cem. conc. culvert, culvt. intakes, etc. A. H. Wright, Clk.

Cal., So. Pasadena—City Mgr., R. V. Orbison, preparing plans for paving El Centro St.—Brent to Pasadena Aves., and Meridian—Oak to Oliver Sts. Est. cost $60,000. Proceedings will be started at once.

Cal., Yosemite Park—By National Parks Rd. bill, Yosemite National Pk., will receive appropriation of $1,500,000 for construction of 128 miles roadway within park. El Portal road is to cost about $30,000 per mile. Abt. 26 miles will cost $20,000 per mile. Other roads will run from $5,000 to $10,000 per mile. A considerable portion of the principal roads will be paved with concrete.

Fla., Miami—Dade County plans to vote on $2,127,743 bonds: For New East Dixie Hwy., $300,000; W. Dixie Hwy., $225,000; widening causeway viaducts, $600,000; canal hwy., $39,593; Everglades Ave., $20,800; Red Road and brdg., $30,250; W. Flagler St. extension and brdg., $52,500; roads in Dist. 4., $80,000; roads in Dist. No. 5, $100,000; complete Tamiami Trail and widen Southeast 8th St., $400,000; extend N. Miami Ave., $50,000; fair grounds, $100,000; Armory, $100,000; Snapper Crk. brdg., $3,000.

Fla., Ocala—Marion County Board of Comnrs., plan to pave (Macadam or other hard surface) 9 roads, $1,500,000 bonds voted. T. D. Lancaster, Jr., Clk.

Fla., Sanford—City plans additional paving on 73½ blocks and widening 8 blocks.

Idaho, Boise—State contemplates considerable constr. program during 1924. Highway work to be advertised in near future includes: FAP 77, abt. 4 mi. in Boundary Co., Approx. cost. $65,000; FAP 71 and 81, abt. 4 mi. Bonner Co., $110,000; FAP 73, Abt. 25 mi. Shoshone Co., $600,000; FAP 75, bridge and overhead nr. Potlatch, $16,000; FAP 67, 3 mi. Lapwai-Spaulding, $30,000; FAP 82, 3½ mi. nr. Viola and Moscow $25,000; FAP 23-C, 14½ mi. Hansen-Murtaugh, Twin Falls Co., $100,000; FAP 70, 8 mi. Murtaugh-Burley, Camas Co., $65,000; FAP 78, 10½ mi. Pocatello-Fort Hall paving, $350,000; FAP 76, 9 mi. Stites-Harpster, $110,000; FAP 8 mi. Kooksia-Kamiah, $115,000; FAP 27, 2 miles Payette-Fruitland, $50,000; In addn. the Bureau of Public Roads will probably let in Idaho, in near future, contracts for following: Bonners Ferry-Moyie Falls, $30,000; Harpster-Elk City, $75,000; 4th of July canyon surfacing, $50,000; Gardena-Horseshoe Bend, $65,000; Victor-Irwin Rd., $53,500; Lolo Pass sec. $100,000; Ketchum-Clayton, $50,000 and Soda Springs-Freedom, $16,000.

Ind., Indianapolis—Department of Public Works has approved Resolution for impvt. of College Ave. (East Side) by grading and paving walks with cement laid next to prop. line, to uniform width of 5 ft., grading lawns to uniform width of 9 ft.; also impvt. of portion of Holmes Ave., 1st alley east of Liberty St. (last named includes grading and paving with asph., conc., conc. or brk. on 6-in. gravel conc. fdn., etc.); also similar work on 1st alley so. of Elm St., on Denny St., no. prop. line of 10th to so. prop. line of 12th Sts.; 1st alley no. of Harvard Pl., 1st alley east of Talbott; Winthrop Ave.,—no. prop. line 54th to so. prop. line of 56th; 1st alley east of New Jersey St., Lambert St.—w. prop. line of Lee to east prop. line of Belmont Ave.; Burton Ave.—no. prop. line 27th to so. prop. line Udell St.

Ia., Davenport—$1,250,000 bonds voted here for 33 miles additional paving. Ready for bids soon. Jos. Wagner, Co. Aud., Scott County.

La., Homer—Claiborne Parish plans to improve 90 miles hard surfaced roads. $800,000 bonds voted. R. Q. Etzel, Clk. Police Jury.

Minn., Hibbing—Village engineer making plans for 25 blocks paving. Will receive bids in summer. J. P. Murphy, Village Clk.

Minn., Willmar—Surveys being made in Kandiyohi County and bids will probably be taken in July for 11 mi. rd. work west of New London; 100,000 c. y. grading; 8 mi. grading in Roseland; 20,000 c.y. grading; 13 mi. rd. wk. bet. Raymond and Sunnyside; 13,000 c.y. grav. H. L. Wood, Co. Engr.

Mo., Jefferson City—State Highway Department, Jefferson City, will receive bids about June 10th for 36 road projects in various counties involving something over 51 miles.

Neb., Omaha—Ords. passed for St. Impvt. Dists. Nos. 2561, 2553, 2557, 2563, 2562, 2559, 2558 and 2549. Paving with asphalt, stone, vit. brick, vit. brick blk. artif. stone, macadam, creo. wood block or asphalt concrete. Jas. P. Hoctor, City Clk.

Nev., Carson City—Following projects will soon be advertised: 12.64 miles gravel surfacing in Elk County—Moor to Pequop Summit; 13.69 mi. gravel surfacing in Pershing Co.—Mill City to Humboldt Line. Plans completed on following projects: 10.25 mi. Churchill Co., 12.64 mi. Elko Co.; 17.20 mi. Elko; 3.20 mi. Clark; 9.63 mi Lyon and 8.09 and 2.40

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Kentucky Rock Asphalt Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Pierce-Arrow Motor Car Co.

Automobiles.
Ford Motor Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Brick, Paving.
National Paving Brick Mfrs. Assn.

Bridges.
Luten, Daniel B.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping
Littleford Brothers.
Pawling & Harnischfeger

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Gun Work.
Indiana Gunite & Const. Co.

Cement Testing.
Chicago Paving Laboratory.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chemists, Engineering
Chicago Paving Laboratory.
Dow & Smith.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Clay Pipe, Vitrified.
Clay Products Assn.

Clay Products.
Clay Products Assn.

Concrete Bridges.
Luten, Daniel B.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Rosing, Inc., Astrid S.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, Burdick & Howson.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Druar & Milinowski.
Flood, Walter H., & Co.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

mi. Humboldt County—all gravel surfacing except 3.20 mi. in Elko which is conc. and gravel. Plans are being prepared on 10.00 mi. gravel surf. Clark Co. across Mormon Mesa, 18.2 mi. in Washoe, and 7 mi. conc. and gravel Washoe Co.

N. C., Raleigh—State Highway Commission plans to construct 4 roads as follows: 6 miles Lincolnton to High Shoals; 10 miles Lincolnton to Alexia, $300,000 (contract to be let soon); 11 miles—Charlotte to Mt. Holly—$325,000; 6 mi.—Rockingham to new Pee Dee River, $175,000. Chas. M. Upham, State Highway Engr.

Okla., Duncan—Stephens County plans 60 miles hard surfaced rds. in County. $2,000,000 available. J. A. Carnes, County Clk.

Okla., Stillwater—Payne County Commrs. plan to hard surf. 3 sections of roads as follows: 37½ mi. from Logan Co. line at Coyle eastward on no. side off Cimarron River to Perkins, then to Cushing and to Creek County line; 17½ mi. from Noble Co. line 9 mi. no. of Stillwater, via Stillwater to Perkins; 26 miles from Stillwater eastward to Creek Co. line, via Yale; vote in June on $1,000,000 bonds; State and ed. Aid $1,000,000.

S. Car., Winnsboro—Fairfield County plans to expend $550,000 for 150 miles sand clay and topsoil roads; also conc. bridges in various sections of County. Bonds sold. Lockwood, Greene & Company, Engineers, Spartanburg, S. C.

S. Dak., Pierre—Will take bids about middle of June for 50 miles grading and bridge constr. throughout the State. State Hwy. Commission, Pierre.

Tenn., Jackson—$890,000 bonds voted for municipal impvts., as follows: Street impvts., $500,000; water plant, $150,000; schools, $115,000; city hall, $125,000. Lawrence Taylor, Mayor.

Tenn., Memphis—City Commission plans to improve 21 streets and alleys. Considering sale of bonds.

Texas, Dallas—City will repair 11 streets, including Main, N. Harwood—Bryan to Ross; Ross, Elm, McKinney, Haskell, Ervay, Forest Aves., Cedar Springs Road, etc. E. A. Kingsley, City Engr.

Tex., Rock Springs—Edwards County contemplates 48 miles permanent paving. Est. cost $404,260. W. E. Simpson Co., Engrs., National Bank Commerce Bldg., San Antonio.

W. Va., Kenova—City plans to pave certain streets. Considering voting on $200,000 bonds.

SEWERAGE AND SEWAGE TREATMENT

Cal., Claremont—$60,000 sewer bond issue carried at recent elec. O. A. Gierlich, Monrovia, Engineer in charge.

Cal., Dos Palos—Plans being completed by Cons. Engr. Andrew Jensen, Rowell Bldg., Fresno, for constr. of sewer system in San. Sewer Dist. Dos Palos, Merced Co. It is probable vit. pipe will be used.

Cal., Elsinore—Burns & McDonnell Engrg. Co., Los Angeles, Cal., preparing plans and estimates for sewers and sewage treating plant for which bonds were recently voted in sum of $50,000.

Cal., La Verne—$60,000 sewer bonds voted here recently.

Cal., Los Angeles—County Supervisors have voted to form sewer dist. to serve Inglewood, Hawthorne, Lennox, Torrance, Lomita, etc., with outfall to ocean.

Cal., Los Angeles—Work will be started on Eagle Rock sewer sys. not later than July st. First sec. in mains to be laid will take in central business section and extend along Eagle Rock blvd.

Cal., Placentia—$85,000 sewer bond issue carried at recent elec. Dist. will immediately join with joint outfall to ocean and build its own line of 4 miles from jct. point to Placentia dist. Inner lines and connections, also laterals, will be built under 1911 Act. San. Board. Wm. Cober, Clk.

Cal., Pomona—City Engr. F. C. Froehde states that bids for construction of 1st unit of new sewer outfall will be called in near future. Sections will run from city toward sewer farm, 1.5 miles and will involve 20-in. and 22-inch vit. pipe. Total length of job is 7 miles.

Ont., Port Elgin—Core, Nasmith & Storrie, Toronto, Cans. Engrs., are in charge of $50,000 sewers and sewage disposal plant to be built here.

Cal., San Diego—City Engr. F. A. Rhodes has has completed plans for new sewer system in Mission Beach, work involving 27,45 lin. ft. 6-in. cem. conc. pipe; 5,470 lin. ft. 10-in. cem. conc. pipe; 6,781 lin. ft. 12-in. cem. conc. pipe; 865 lin. ft. 8-in. cast iron pipe, 40,196 lin. ft. trenching and laying sewers from 4-12 ft. deep; 87 conc. manholes with cast iron covers; 40 drop manholes, conc. with c. i. covers; 46 deadends; 13 deadends with cross; 6 flush tanks; 3 pump stations with houses and equipt.; 1 settling tank; 1,200 lin. ft. c. i. pipe; outfall.

Cal., San Fernando—$90,000 bonds voted here for sewerage system. Bids will be asked as soon as prelim. details are disposed of.

Cal., Santa Barbara—$407,000 sewer bonds voted at recent election. It will probably be late in summer before construction starts. Plans contemplate 4,000 ft. ocean outfall of either cement pipe or cast iron. Design of outfall involves installation of 2 equalizer pumps, 40,000 gals. each, screening plant for emergencies. City Mgr. Herbert C. Nunn.

Cal., Santa Rosa—Plans being completed by Cons. Engr., Clyde F. Smith, 716 Santa Barbara Rd., Berkeley, and bids will be called for shortly by Council for constr. of activated sludge sewage disposal plant. Bids will be called for on (1) Furnishing mechanical equipment; (2) installing equipt., and constrcuing plant. Est. cost $165,000.

Cal., Williams—$40,000 bonds voted here for sewerage system.

B. C., Point Grey—A trunk sewer to cost $250,000 will be laid on Alma Rd., to Imperial St. Jas. Stables, Engr.

Ont., St. Thomas—Plans and specfs. for new sewage disposal plant, est. to cost $80,000, prepared by City Engr. Miller of Toronto. Bids will be called for when plans are approved.

B. C., Vancouver—Plans being prepared in offices Vancouver & Dist. Joint Sewerage and Drainage Board's Engineer, Jos. Slater, for new sewer outfall interceptor and Alma Road Imperial street outfall to be placed under construction in near future. Plans will be submitted to Board for approval at next monthly meeting. Both projects est. to cost total of $250,000.

Colo., Denver—City plans 16 miles of 8 to 24-inch sewers in Globeville San. Sewer Dist. Est. cost $234,300. A. K. Vickery, City Hall, Engr.

Fla., Melbourne—Election soon to vote on $35,000 bonds for sewer system.

Mich., Detroit—Plans being prepared for 26,050 ft. Lat. 4122, 680 ft. 4-ft. 6-in. vit. pipe and 2-ring brk., including 348 ft. 4-ft., 548 ft. 3-ft. 6-in., 284 ft. 3-ft. and 345 ft. 2-ft. 6-in.; 1,700 ft. lat. 4114, 12-15-in. vit. pipe; 2678 ft. Lat. 4119, 12-24-in.; 770 ft. Lat. 4121, 18-30-in. pipe. G. Jerome, City Engr.

Minn., Le Sueur Ctr.—Louis P. Wolff, 1000 Guardian Life Bldg., St. Paul, making plans and surveys for san. and storm sewers here. Probably mature late in spring or summer. A. A. Tambourino, Vil. Clk.

Miss., Natchez—City (L. A. Whittington, Mayor) has plans by Henry A. Mentz, Cons. Engr., for impvts. to sewer system, $27,000; also has under consideration expendt. of $40,000 for impvts. to pumping station.

Mo., Hannibal—Prelim. plans being made for 36,000 ft. storm and san. sewers in So. Side Sewer Dist, $76,000. W. R. Gettler, City Hall, Engr.

Mo., St. Louis—Prelim. plans being made for repairing Southern sewer and extending outlet into Mississippi River. Est. cost $113,500. W. W. Horner, 300 City Hall, Engr.

Neb., Louisville—Plans approved by State San. Engineer for sewer system here. No septic tank.

N. C., Walnut Cove—Plans being prepared for 10,500 ft. 8 and 10-inch san. sewers and water mains. Piedmont Engineers, 412½ Trade St., Winston-Salem, Cons. Engrs.

Ohio, Garfield Heights—(Cleveland, P. O.)—Will take bids in July for 5 miles vit. and segmental blk. sewers. R. F. Munz, Town Hall, Engr.

Ore., Marshfield—City Council has issued orders to replace old mill slough drain and determine Dist. which would be liable for assessments. Approx. cost of wooden sewer would be $80,000.

Ore., Vernonia—City authorities contemplate constructing a $40,000 sewage disposal plant here.

S. C., Greenville—Fred Burnett and associates, developers of Washington Heights, will construct

BUYERS' GUIDE

Deep Well Pumps.
Harris Air Pump Co.
Keystone Driller Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.
Rosing, Inc., Astrid S.

Dryers.
Cummer & Son, The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Machinery.
Westinghouse Electric & Mfg. Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Excavating Machinery.
Austin Machinery Corp.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co., Inc.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Gates, Sluice.
Coldwell-Wilcox Co.

Graders.
Austin-Western Road Machinery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gunite.
Indiana Gunite & Const. Co.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Mead-Morrison Mfg. Co.

Hot Mixers.
Austin Machinery Corp.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corp.
Koehring Co.
T. L. Smith Co.

Motor Fire Apparatus.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Duplex Truck Co.
Federal Motor Truck Co.
Ford Motor Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers, and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Murpysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip. The
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

about 1,500 lin. ft. 8-inch sewer to connect with city mains. Work will be under direction of W. D. Neyes, City Engr.

Tenn., Knoxville—City (Jno. C. Borden, Director of Finance), will sell $200,000 impvt. notes to complete Oakwood sewer line. Plans completed.

Tex., El Paso—City voted $1,045,000 bonds, including $100,000, for sewers, $9,000 for drainage.

Texas, Luling—City having plans prepared by Koch & Fowler, Engrs., Dallas, Texas, for sewerage system and disposal plant. Est. cost $40,000.

Texas, Waco—Advices from the Terrell-Bartlett Engineers, Inc., 610 Calcasieu Bldg., San Antonio, Texas, engineers for sewage disposal plant, state that work will probably be ready for bids some time in August. Plant will either be Imhoff tanks and sprinkling filters, or an activated sludge plant. $350,000 available.

Texas, Winters—$50,000 voted by City for sewer bonds. Municipal Engineering Co., Praetorian Bldg. Elrod, Dallas.

Wn., Centralia—$60,000 bonds voted for extension to san. sewerage system.

Wash., Hoquiam—City plans sewerage system for East Side. Est. cost $46,500. W. L. Lovejoy, City Engr.

W. Va., Morgantown—City considering voting on $700,000 bonds for sewer and streets impvts. G. H. Bayles, City Mgr.

WATER SUPPLY AND PURIFICATION

Ariz., Flagstaff—Burns and McDonnell, 415 Marsh-Strong Bldg., Los Angeles, have made final report on water impvts. for Flagstaff. Bond elec. will be called in near future covering $375,000, which includes a 50,000,000-gal. conc. reservoir, new pipe line from Springs and extensions to mains.

Ariz., Williams—Bonds voted here for $50,000 covering waterworks impvts. Plans and surveys under way by Burns and McDonnell Engrg. Co. (work to be handled by Los Angeles office). Work will include enlarging present reservoir and dam, giving capy. of 36,000,000 gals.

Cal., Culver City—Water works impvt. bonds will be voted on at early date in sum of $300,000. Olmsted and Gillelen, Hollingsworth Bldg., Los Angeles, Cons. Engrs.

Cal., El Centro—$200,000 bonds carried at recent election. Work contemplated includes new salt basin, additional machinery, a filter, together with larger water mains for fire protection.

Cal., Escondido—Mutual Water Co., local, has published constr. program for present year. Includes lining main canal upstream from Hell Hole syphon, 22,462 ft. and installing 42-in. steel syphon across Hell Hole creek canyon. Syphon will displace over 15,000 ft. dirt canal and will be 1,800 ft. in length. Jas. B. Dixon, Supt. of Company.

Cal., Los Angeles—Bureau of Water Works (Wm. Mulholland, Chf. Engr) has completed plans for 12-in. water main and laterals to be constructed along the line of the Mulholland Dr., serving territory adjacent to that hwy. When plans are approved a special bonding dist. will be formed and vote taken on bond issue. Two separate systems will be maintained—one west of Cahuenga Pass to be supplied from upper Franklin Reservoir, while sys. east of the Pass will be supplied from Weid Canyon Reservoir.

Cal., San Bernardino—$275,000 water bond issue carried at recent election. Funds derived are to be used for development of Devil Canyon Project.

Cal., Santa Barbara—Construction of a 12-in. water main on State St. bet. Sola and Gutierrez Streets, will be started about July 1st. Est. cost $50,000. Pipe will probably be purchased at once. Geo. D. Morrison, City Engr.

Ont., Chippawa—$150,000 water and sewage system considered.

Ont., London—Report that promiment insurance men are urging City to authorize constr. of additional water main to Springbank. Plans prepared by E. V. Buchanan, Pub. Utilities Mgr. Est. cost $300,000.

Que., St. Lambert—Filtration plant to cost $100,000 will probably be installed this summer.

Ont., Toronto—City considering installation of high pressure fire pump at main pumping station. Est cost $112,000. R. C. Harris, City Engr.

Fla., Fort Pierce—City will vote July 1st on $500,000 bond issue to include following: $125,000 for water extension and impvts.; $100,000 for storm and san. sewers; $70,000 for paving; $50,000 for City Hall; $10,000 for seawall, etc., etc.

Ky., Paintsville—City will open constr. and machinery bids about July 1st for constr. of new water plant; brick bldg., complete filtration plant in same bldg.; 250,000 gals. capy.; install 250,000 gal. steel tank and 2 large elec. or gas-driven pumps; also 3 miles water mains. Est. cost $70,000. The J. N. Chester Engrs., Pittsburgh, Pa., Cons. Engrs.

La., Donaldsonville—Municipal Light & Water Comn. has plans for impvts. to water sys.; will lay 14-in. cast iron pipe, install suction pump, etc.

Md., Baltimore—City (V. Bernard Siems, Water Engr.) plans to restore Druid Lake in Druid Park as source of water supply for low pressure area of City. Plans call for constr. of feed line from Montebello to lake at cost of $800,000; conc. water tunnel 8 ft. in diam. from filtration plant at Montebello to Taylor Ave. and 25th St. V. Bernard Siems, Water Engineer, will take over, for City of Baltimore, and operate Ridgewood Water SCompany's plant.

Mass., Boston—City contemplates appropriating $800,000 for relaying old Tremont Street pipes.

Mich., Iron Mountain—Plans accepted for filtration plant and storage reservoir. Est. cost $190,000. Pipe line to City.

Mo., Columbia—Water and Light Comn., City Council, (T. H. Rodhouse, Chmn.) plans to expend $190,000 during next 18 months for extens. and impvts. to water and light plant.

N. Y., Fulton—City Council has approved expenditures for main extension, re-equipment of water works with modern pumps and linking Johnson Springs with present supply. Est. cost $200,000.

N. Y., Syracuse—Water Department considering construction of reservoir estimated to cost $500,000. C. R. Knapp, Mayor.

N. Car., Mt. Holly—Town receives bids in about 60 days for water filtration plant. Carolina Engrg. Co. Cons. Engineers, 412 Southern Bldg., Wilmington, N. C.

N. C., Winston-Salem—Board of Aldermen voted to issue $1,100,000 street assessment bonds. Included is $750,000 for enlarging water system; $75,000 for incierator plant, etc.

Okla., Heavener—Construction of water works system extensions planned. Est. cost $156,000. C. W. Mizell, City Mgr. V. V. Long & Co., Cons. Engineers.

Okla., Stillwater—$200,000 bonds voted here for earth dam, pipe lines, main extensions, etc. G. F. Matkin, City Clk.

Ore., Seaside—Application made for 8 cu. ft. per second of water from so. fork of the Necanicum river for municipal purposes. Pipe line is to be 9½ miles long. Est. cost $180,000.

R. I., Woonsocket—Resolution passed to request General Assembly to amend bill before House of Representatives for water works constr., raising cost from $100,00 to $600,000.

S. D., Sioux Falls—City will build over 7 miles water mains this year in various streets. Jno. Murdt, Water and Sewer Engineer.

Texas, Austin—Board of Water Engineers (A. H. Dunlap) has selected 2 sites for proposed erection of reservoirs on Pecos River. Est. cost abt. $2,000,000. Reservoir will supply water for farmers' independent project at Cedarville, Portervfile. Barstow and Grand Falls in Crane, Ward, Pecos and Reeves Cos.

Texas, Dallas—City will ask for bids about July 15 for construction of $3,000,000 water reservoir on Trinity River. H. R. Davis, Mayor; Nagle & Thompson, Cons. Engrs., 2003½ Main St., Dallas.

Wash., Bellingham—Plans $200,000 bond issue, extending and improving water system in northern section of City.

Wis., Madison—Will construct dam on Menomonie River on Wisconsin and Michigan boundary. Owners: Ford Hydro-Electric Power Co. Permit issued. Est. cost $250,000.

BUYERS' GUIDE

Pumps.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.

Rock Asphalt.
Kentucky Rock Asphalt Co.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Scarifiers.
Austin-Western Road Machinery Co., The

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

Scrapers, Power.
Sauerman Bros.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
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